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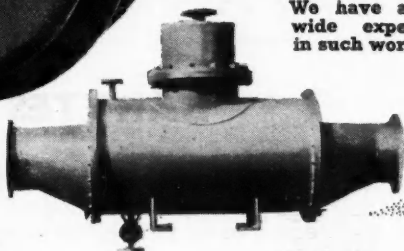


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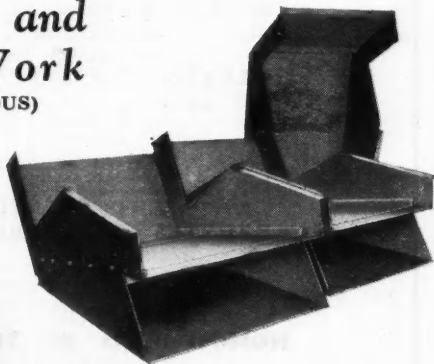
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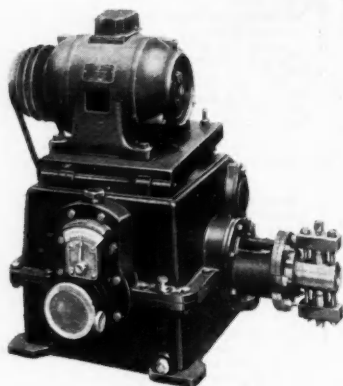
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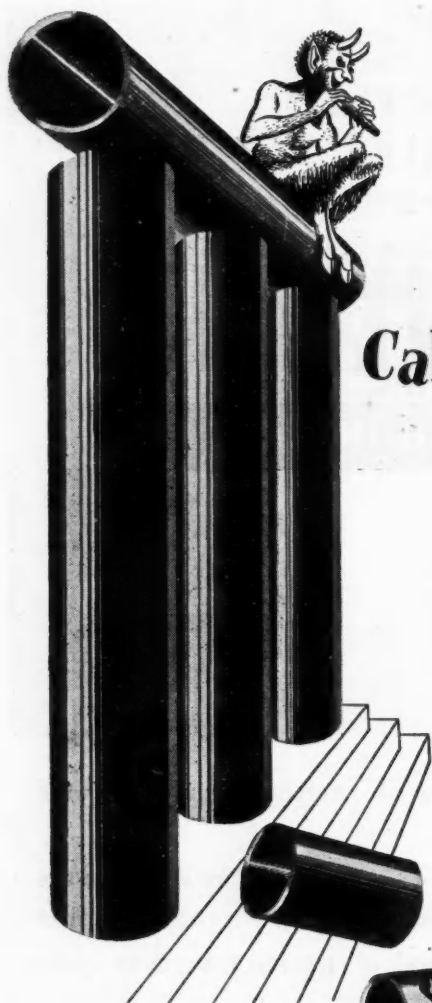
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G.11




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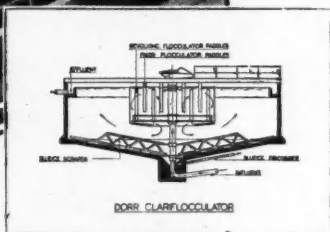
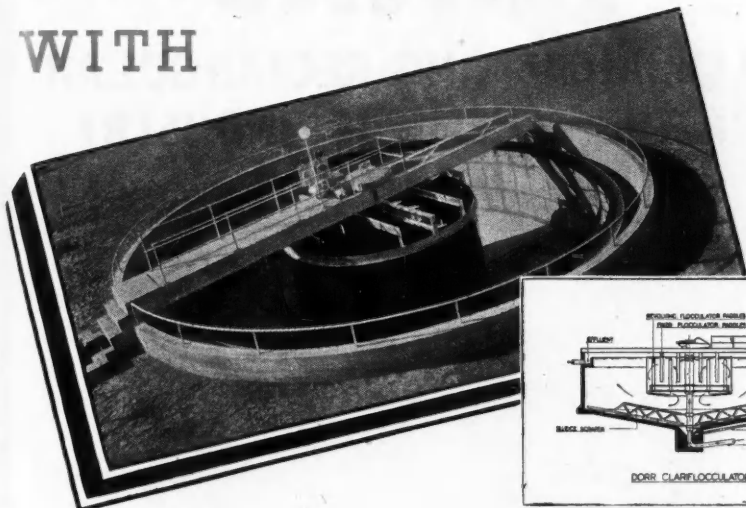
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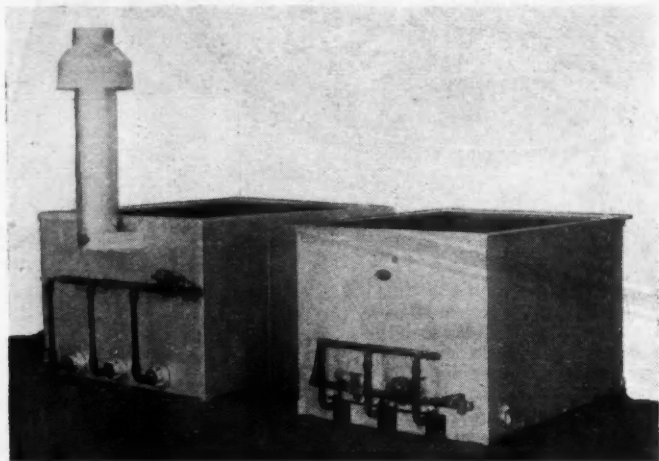
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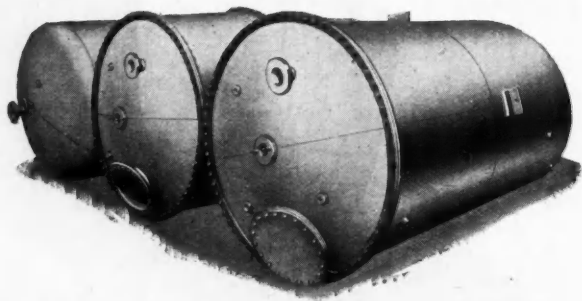
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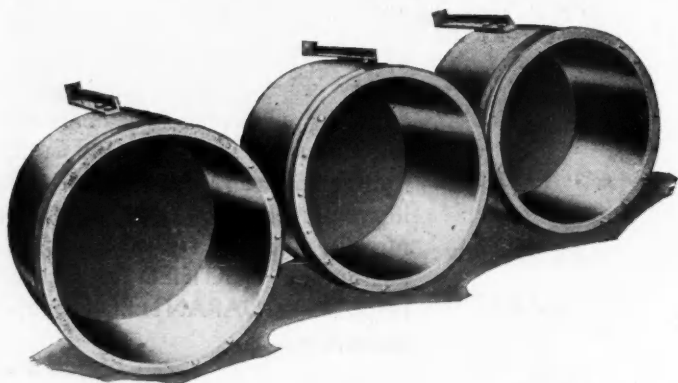
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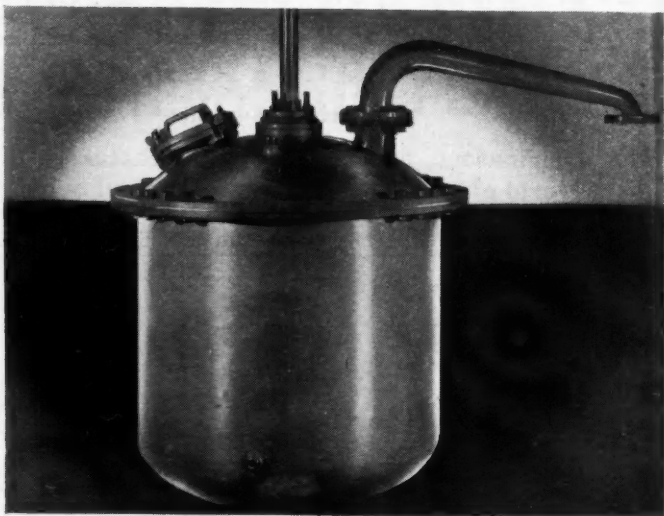
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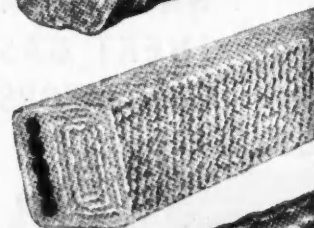
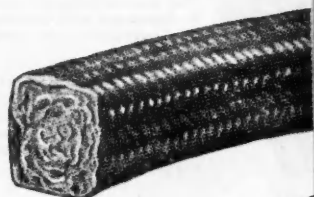
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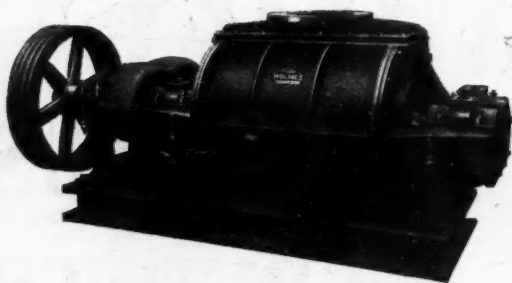
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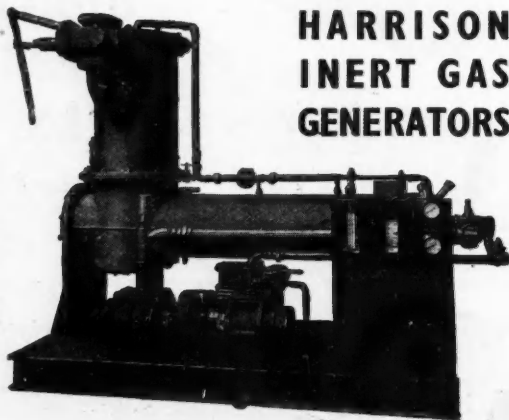


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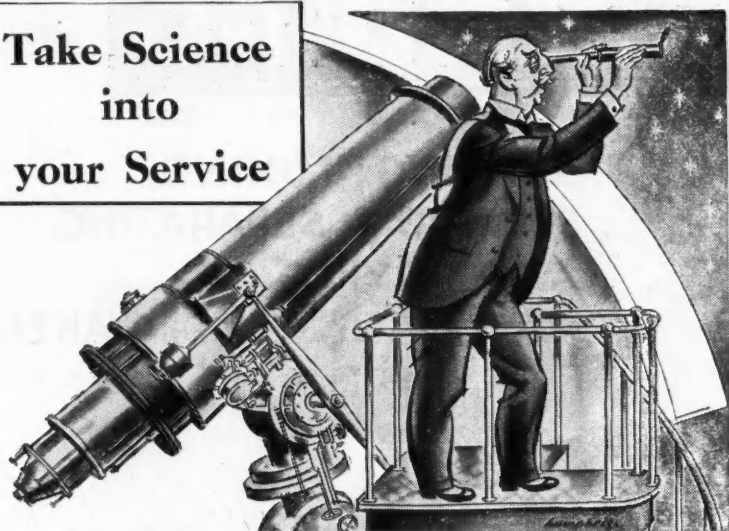


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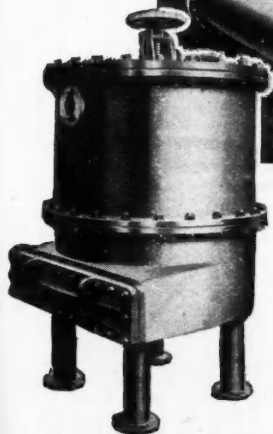
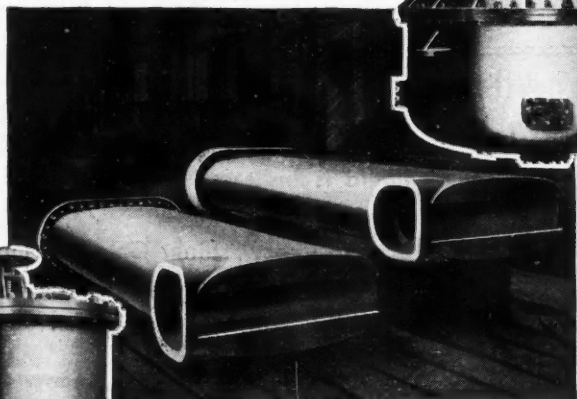
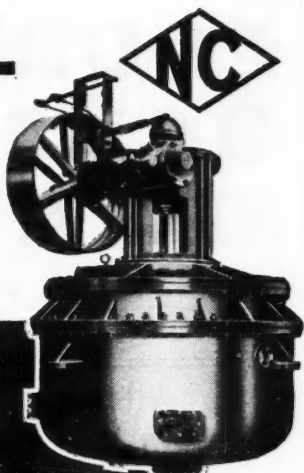
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TOP RIGHT. Jacketed Paddle Mixer

CENTRE. Retorts in Heat-Resisting Cast Iron.

LOWER LEFT. Sulphur Burner.

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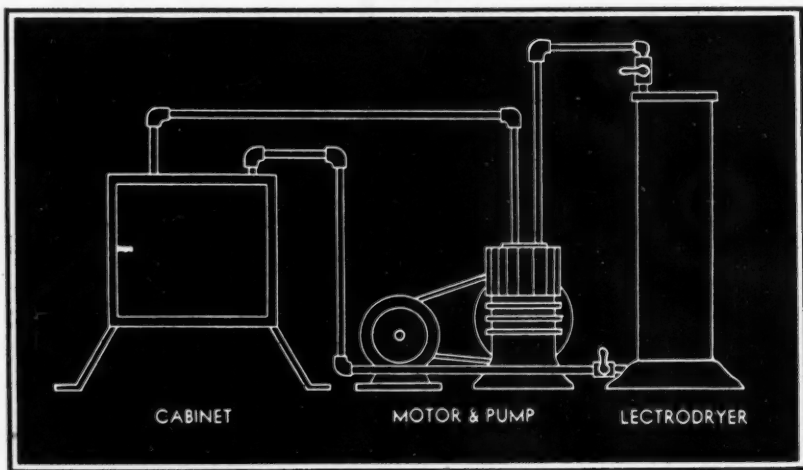
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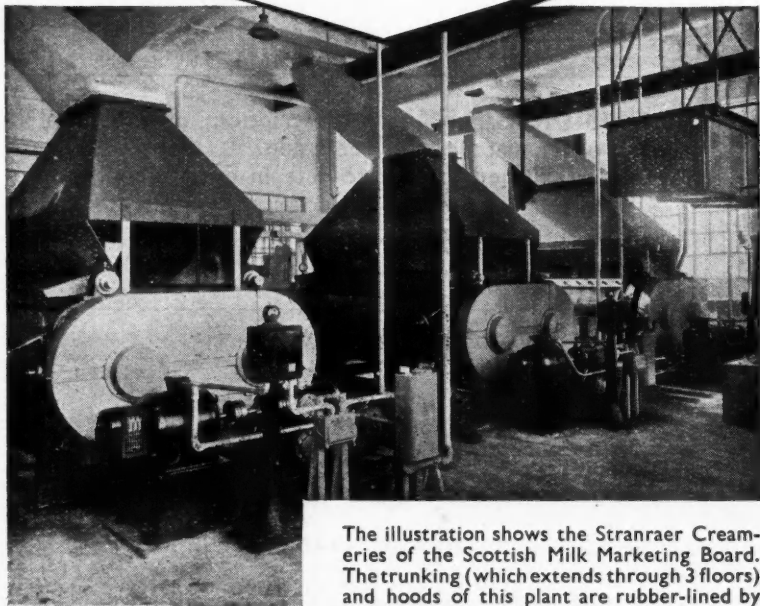
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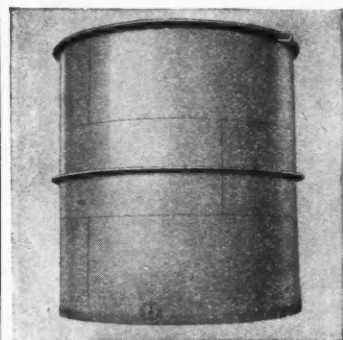
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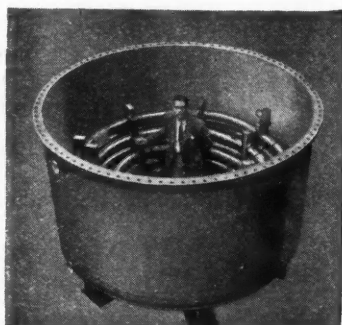
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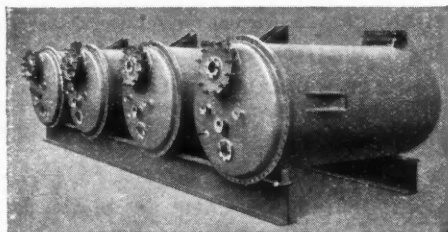
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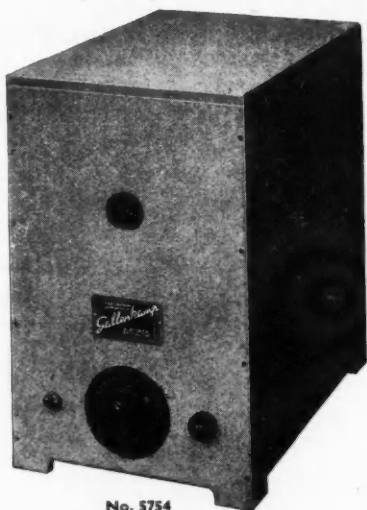
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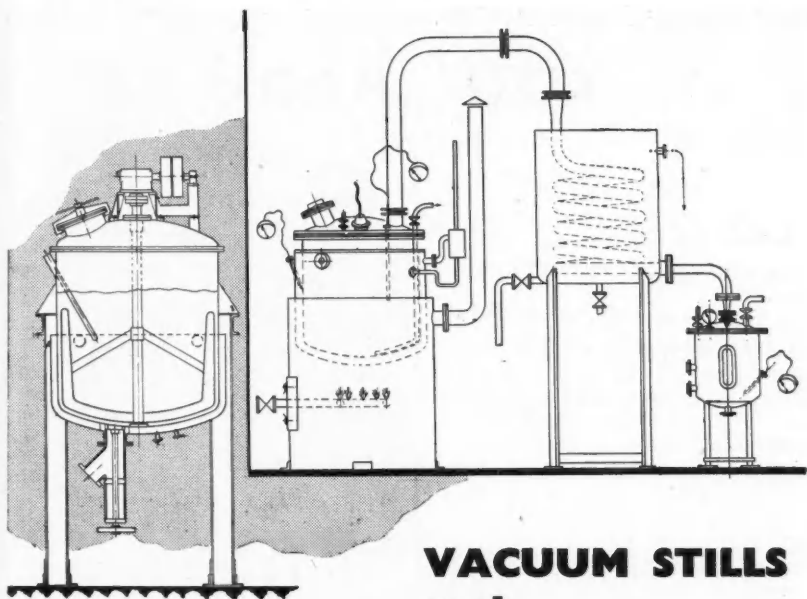
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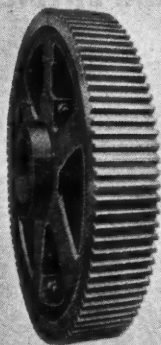
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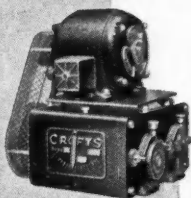
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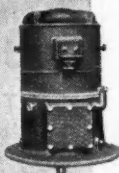
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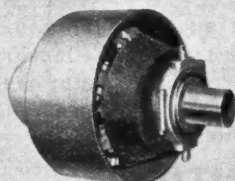
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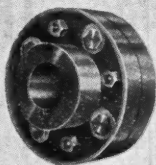
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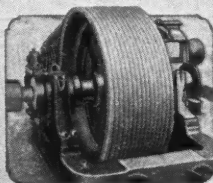
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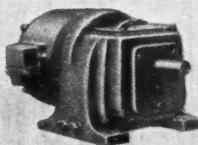
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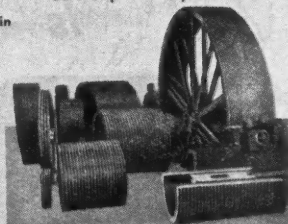
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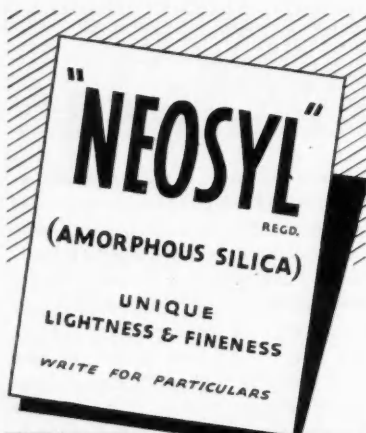
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Page 17

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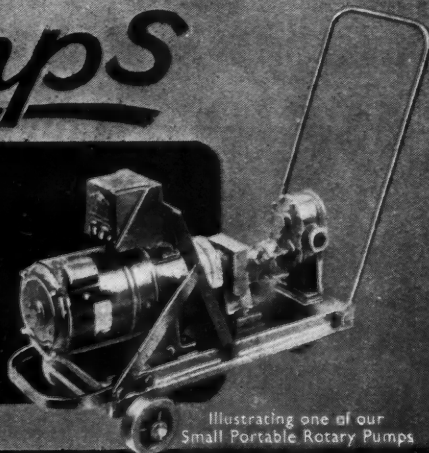
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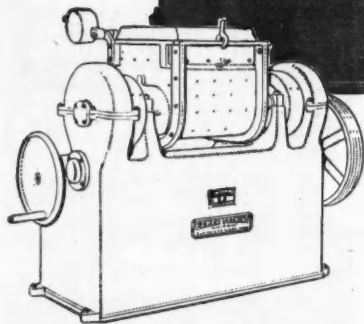
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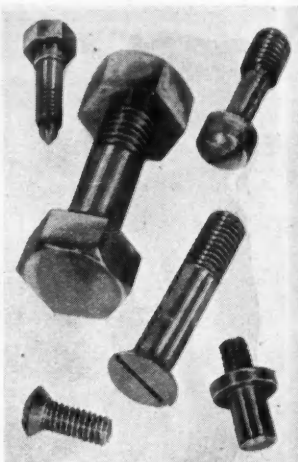
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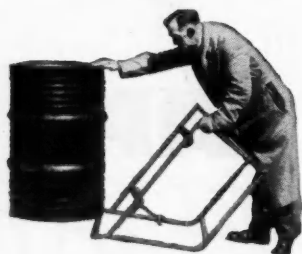
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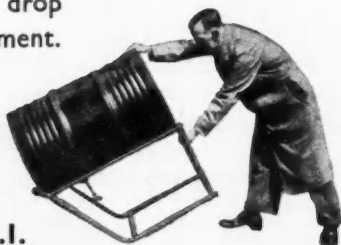
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"Spring Cleaning" in Industry

THE sayings of our grandfathers often lie about our necks like millstones. Those old gentlemen of a past, a vanished age, were wont to express their thoughts with decision and emphasis. They were right and they knew they were right; how could the lords of the universe be wrong? So they presented us with a series of sayings that in time acquired the dignity of proverbs. No one would think of calling in question the rightness of the sentiments expressed by a proverb—were it not that to most proverbs there is as antidote another proverb which says the reverse.

So, amid the sayings of the Great Men of Business of the past, there has come down to us a saying from the hardy North, a saying that was quoted to us when young every time things looked to be in somewhat of a mess. It ran: "Where there's muck, there's money."

Although we did not recognise it as such in those days, it was in fact an excuse for slovenliness and dirt where by rights all should have been clean and tidy. It epitomises in almost proverbial form the philosophy of those days. It would cost "brass" to tidy up the working place, and besides men would have to leave off their work to do so—and that would never do. So the cutlers of Sheffield, the workers on coke ovens, on

chemical works, on tar works, and elsewhere wherever "myself when young did eagerly frequent" were condemned to pass most of their working hours, and that meant a high proportion of their waking hours, amid dirt and squalor, poisoned air, and poverty, upon the excuse that "where there's muck, there's money."

That, too, was the excuse for the blackened buildings and smoke-grimed air of our great industrial cities. Smoke, which we now know to be the very symbol of avoidable waste, was for centuries the outward and visible sign of a busy town. The more smoke pouring from tall chimneys into the heavens, the more work was being done. The more smoke belching from the chimneys of dwellings the more prosperous were those who dwelled therein. The "muck" was the outer, visible sign that "brass"

was being earned in plenty.

Even in those days there were hardy rebels who did not believe in the traditions of their forefathers. Garden cities were not unknown. Bourneville village had shown that industry need not be dirty to be prosperous—but then, of course, the manufactures conducted by Messrs. Cadbury were not dirty, so the majority were still able to excuse their slovenliness. We well remember the storm of amused comment, not

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unmixed with indignation, when the manager of a coking plant near Sheffield had lawns laid around his office and the works; not only had them laid but employed men to keep them in good order! Could foolishness go deeper than that? How could such a man expect to keep his job?

But the result more than justified the means. There is no doubt whatever that we spend most of our time at our works and that our ideas are moulded by our environment. If men work in a well-kept factory, amid pleasant surroundings, they will mould their behaviour upon their environment. They will work harder and to better effect; ideas will come more frequently. The work will be done better for being done more tidily. In the modern world, where there is muck, there will be found inefficiency and waste, ending ultimately in financial loss. The 19th century, with all its dirt, was terribly inefficient.

The new Chief Inspector of Factories, Mr. H. E. Chasteney, has signalled his first annual report by calling upon British industry for a "spring-clean." British factories, he says in so many words, need cleansing, tidying up, repairing and refitting to bring them back to their pre-war standard. They need the introduction of more light and colour to brighten them and take them a step beyond that standard; and moreover they need all this to lift welfare arrangements to the standards required by the Factories Act. Admittedly, there has been no such marked deterioration as followed the 1914-18 war in the guarding of machinery, in spite of the difficulties of shortage of labour and materials. Standards of dust and fume removal were upon the whole well maintained. The lighting and amenities of war factories were on a high level and men and women got used to working—and working well—in pleasant surroundings. The number of canteens serving hot meals grew from 1500 before the war to 12,000 during those fateful years. But many of these improvements have not spread to the normal factories of peace, and throughout all industry there is a great deal of maintenance and repair yet to be undertaken. The removal of the black-out disclosed more dirt and "muck" than many believed could exist in occupied premises. The Chief Inspector recalls one factory where the management, shocked by what the removal of black-out disclosed, stopped production for 10 days and put all the workers on to tidying up; no less than 93 tons of

dirt, waste and rubbish were removed. Not every firm can do things in so princely a way; not every firm gets itself so cluttered up that it cannot go on until it has had a "spring clean."

In endeavouring to put these precepts into practice, there are many difficulties. Not the least is the continuing shortage of materials. We cannot become tidy without a permit. There are bombed offices which still have their walls cracked and their decorations sadly reminiscent of the doourest poverty of the garret, because no Ministry will grant a permit for the necessary materials and labour. Our streets and our houses are as drab as our lives under the enforced austerity which has been wished upon us by a Government that promised us much and gave us—austerity. The incentive to brighten ourselves and our lives is lacking. Our towns, London not least of all, are drab and uninteresting. More over, with the best will in the world, many older factories can never be modernised. They require to be rebuilt before they can be made to fit in with modern standards. These works and factories have grown slowly with the years, the decades, almost with the centuries. A bit has been added here and there, as the need dictated, but without any long-range planning for greater production at a later date.

The result is that complete re-building is now necessary. But the men and the materials to rebuild are not available; no permit will be given for that sort of building. Moreover, capital is necessary, and the capital is equally difficult to acquire when taxation is ruinously high. If industry does not "spring-clean" this year, we suggest that the Chief Inspector will be able to tell his Government the reason why.

Nevertheless, difficulties apart, whatever can be done to follow the Inspector's recommendations should be done. We have to work out our own salvation. We should have learnt enough to know that. As part of the very great contribution that industry will make and must make to the building of a better Britain, the brightening and cleaning-up of the places wherein men and women work should be a primary objective.

Let us have no more "dark Satanic mills." We believe that even the dirtiest chemical process could be conducted under good conditions if the right spirit were inculcated into the men, if the plant were maintained in proper order—and that means really first-class maintenance—and the management were enthusiastic.

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THE HEAVY CHEMICAL INDUSTRY IN 1946

by P. PARRISH, F.R.I.C., F.C.S., M.I.Chem.E., F.I.I.A.

THE chemical industry during 1946 has accorded a hearty welcome to a large number of men from the Forces, some of whom were well-trained chemical process workers before the war. Generally, their introduction to the chemical factories of the country has been most salutary, leading to a greater efficiency of process operation, and more economical working. On the other hand, it has been necessary to receive a large number of demobilised men from the Services, who hitherto had no knowledge of chemical operations. Many of these men had to be trained for process work, and not a few, when trained, have decided that the work was not nearly so congenial as they had hoped, or on the other hand, they felt that they might be successful in obtaining a more favourable situation elsewhere. The experience of some factories has been that only about one in four has remained. This tentative period has undoubtedly been an expensive one, and will reflect itself in the balance sheets of many undertakings.

Effects of Legislation

Again, it has been found that the Factories Act, 1937, which had scarcely been applied in its entirety before the Munich crisis, is now to be applied in all its manifestations. This imposes the need for extra vigilance on the part of chemical engineers and works managers. Further, the Building Trade Regulations, which are likely to be introduced very shortly in the form of an Act, seek to enforce safety measures with regard to the method of erection of structures and appliances used to support scaffolding, inspection and maintenance of working platforms and stages, stairs, gangways, openings in walls, floors, roofs, platforms, etc.

Thus, an engineer whose primary responsibility will be to examine and certify the suitability of everything provided for under the Factories Act, 1937, and the Building Trade Regulations, becomes a necessity in any chemical works of any size. Smaller works may be able to relegate the examination and certification to Insurance Companies, who, it is believed, are willing to undertake such work.

In this post-war era, more than ever before, the condition of our national survival is industrial efficiency.¹ For good or ill the *laissez-faire* methods in industry and commerce of the last century and the cartels and manufacturing associations of the past fifty years are now being replaced by a

degree of organised planning hitherto unknown, in which individual interest and desire are subordinated to the will of the government. It is clear, also, that those cartels which do remain will be subject to official control and jurisdiction. Is such guidance likely to lead to increased efficiency in industry as a whole, for it is by this criterion alone that the success of any scheme may be judged? Much—in fact, all—depends on how the government uses its power and what foresight and anticipation are displayed by those to whom the task is entrusted.

That Government planning, where necessary, should be on broad lines and that it should bring to industry specific information and general guidance, so that decisions compatible with the national interest may be taken with certainty and full knowledge of all facts, is generally conceded. While it is certainly not the function of Government planning to interfere with the day-to-day administration, there are many spheres where such planning would be helpful—even vital—to increased industrial efficiency. No system of cartelisation, zoning or subsidies can meet with long-term success unless each part of every industry takes efficiency, and that alone, as the key to its operations. If this view is recognised, then Government planning can assist our industry to establish itself satisfactorily and permanently in world markets.

Alkali

Last year the author dealt in some detail with the ammonia-soda process: it is one which is full of interest and lends itself to imaginative development. The latter has been exemplified by the Wyandotte Chemical Corporation at Wyandotte, Mich. This company is fortunate in owning limestone quarries, salt wells, and coal mines, and advantage is taken of these resources to produce chlorine, caustic soda, calcium carbonate, calcium chloride, soda ash, sodium bicarbonate, and dry ice. The coke ovens afford a supply of coke to the vertical limestone kilns, ammonia is the basis of the ammonia-soda process and benzene, toluene and xylene, fuel gas and tar are the basis of organic chemicals, should it be desired to develop these.

The lime kilns provide carbon dioxide for the dry ice plant and for the carbonator and recarbonator of the sodium bicarbonate plant. A portion of the bicarbonate formed in the carbonator is sent to the soda ash

department, where it becomes the raw material. Some of the sodium carbonate from the soda ash plant passes to the calcium carbonate plant, where it is reacted on with calcium chloride to form various grades of precipitated calcium carbonate. Another part of the sodium carbonate is used in the causticisers with milk of lime to form caustic soda, which is conveyed to the caustic soda plant. Lime, the solid product of the kilns, is slaked and then used in the causticising portion just referred to, and lime reacts with the ammonium chloride in the distilling unit to form ammonium hydroxide. Brine is chiefly employed for making chlorine and caustic soda. The former is dried and liquefied for the market, while the latter is transferred to the finishing plant. Here it is combined with caustic soda produced in the causticisers of the calcium carbonate plant. Other brine from the wells is purified and pumped to the absorber, in which it is mixed with ammonia from the ammonia distilling unit of the by-product plant to form ammoniated brine, which is the starting-point of the ammonia-soda process. It is used in the carbonator of the sodium bicarbonate plant.

Chemical and Metallurgical Engineering provides a pictorial diagram and photographs of the integrated alkali industry, which must be the admiration of all chemical engineers, and this is supported by twelve photographic representations of the plant at various stages, which reveal the handling of the raw materials and products and the chemical engineering operations. These photographs are singularly impressive.

Aluminium

A recently published report on progress in the anodic oxidation of aluminium is of peculiar interest, in view of the ever-increasing use of this metal for domestic purposes. Although the remarkable protective qualities of the extremely thin film of alumina naturally formed on the surface of aluminium has been known for some time, it is only comparatively recently that methods have been developed to supplement this film by means of artificial oxidation. Notwithstanding much study of the subject by various investigators, however, and the use of modern X-ray and electron-diffraction methods, the structure and mechanism of formation of the anodic film are not yet fully understood. Among the various methods of producing this film that are employed commercially, the sulphuric acid anodic method now predominates. Apart from economic advantages, it allows of precise control and flexibility to meet varying conditions and requirements.

Anodic coatings are generally from 0.001 to 0.0006 in. thick, i.e., from 100 to 1000 times the thickness of the natural film. The

formation of the anodic film and its properties depend on the constituents present in the metal. With pure aluminium the coating is substantially alumina, continuous and transparent. Some alloy elements (e.g., silicon), remain unchanged during electrolytic treatment, and microphotographs show the silicon particles occupying the same relative positions in the film as in the natural metal. On the other hand, with CuAl, and β Al-Mg these are dissolved or oxidised much more rapidly than the aluminium matrix. Anodic coatings are porous, although according to present theory, there appears to be a barrier layer of oxide at the base of the pores separating them from the metal. It is estimated that there are over 1000 million pore centres per sq. in., but these are large enough to permit entrance of the current-carrying aqueous solution and to admit of the film being coloured by dye adsorption.³

Synthetic and Product Ammonia

In past reviews attention has been directed to the improvements in the synthesis of ammonia, the types of catalysts and accelerators that have been developed from time to time, and the various pressures at which catalysis is effected. No attempt has been made to contrast what may now be regarded as the standard methods of producing ammonium sulphate from (a) synthetic, and (b) product ammonia.

The Billingham works is fortunate in being situated on an anhydrite deposit of some considerable depth and tonnage. The Indian plant which is to produce 350,000 tons of sulphate of ammonia annually is being designed to employ selenitic gypsum.

The conversion to sulphate⁴ involves the preparation of a mixture of ammonium carbonate and bicarbonate in a carbonating tower. The ammonia is derived synthetically and the CO₂ arises from the hydrogen plant. Finely-ground anhydrite is introduced to reaction vessels working in a series of eight. The reaction proceeds practically to completion, with the formation of ammonium sulphate solution (28 to 30 per cent) and the precipitation of chalk. Separation of the chalk from the magma and the removal of as much of the absorbed ammonium sulphate solution as possible from the precipitate is effected by two-stage clarification in settling tanks. Rotary vacuum filters, equipped with woollen filter cloths, are used for the two-stage filtration. Magma from the reaction vessels is pumped to the primary filters, the cake which forms being washed with the effluent liquor from the secondary filters. The dried cake, blown off the cloth by compressed air, is repulped with waste liquor from the secondary filters. Water, heated by low-pressure steam, is utilised to wash the cake formed

on the secondary filters, the filter effluent passing to the primary filters for washing and repulping.

The cake from the secondary filters—mainly chalk with the insoluble impurities from the anhydrite and small quantities of dissolved ammonium sulphate—is used in the manufacture of Portland cement clinker, for the production of Nitro-chalk, or as a lime dressing for agricultural purposes.

Strong hot liquor from the primary filters

the filters is washed with feed liquor, while the filtrate is returned to the evaporators. The ammonium sulphate crystals are dried in two rotary dryers, the products from the combustion of coke-oven gas being used. The hot dry crystals then pass through two rotary coolers. Lifters are fitted to the internal surfaces of the coolers to expose the crystals to air, thus ensuring a maximum degree of cooling. Crystallised, cooled salt is carried by a band conveyor to an air-

Unit operation	Synthetic Ammonia
1.	Mining of anhydrite.
2.	Grinding and screening.
3.	Carbonating of liquor ammonia.
4.	Reaction of ammonium carbonate and bicarbonate with ground anhydrite.
5.	Filtration to separate ammonium sulphate solution from calcium carbonate, in rotary filters.
6.	Treatment of calcium carbonate for production of Portland cement and Nitro-chalk.
7.	Clarification of ammonium sulphate solution.
8.	Evaporation of ammonium sulphate solution, 28-30 per cent $(\text{NH}_4)_2\text{SO}_4$.
9.	Separation of crystalline pulp.
10.	Centrifuging.
11.	Drying.
12.	Cooling.
13.	Discharge to stores.

Product Ammonia.
Production of sulphuric acid from spent oxide.
Distillation of gas liquor or concentrated gas liquor or mixtures of the two.
Absorption of ammonia in sulphuric acid in saturator.
Simultaneous neutralising and centrifuging in centrifugal basket.
Drying.
Discharge to stores.

is clarified in settling tanks. The accumulated deposit from the bottom of the clarifying tanks is withdrawn at fairly long intervals.

From the clarifying tanks, the liquor is pumped to boilers, to remove traces of ammonia and carbon dioxide. The vapours from the boiling liquor, consisting of steam, carbon dioxide and ammonia, are passed through a fractionating column, and then through two condensers in series. The condensate from the first condenser is returned to the top of the fractionating column, while the ammoniacal liquor from the secondary condenser is recycled to the beginning of the process.

Crystallisation of the ammonium sulphate is undertaken in single-stage vacuum evaporators with indirect steam heating. From the base of the evaporator the crystalline magma is pumped to a separator, from which the crystalline fraction passes down to the salt filter. Final separation of the ammonium sulphate crystals is effected in a rotary vacuum filter. The crystal bed on

conditioned storage silo, from which it is bagged for export. Staybrite steel of the 18 chrome-8 nickel-1 tungsten-1 titanium-type is largely used in the construction of the vessels and pumps on the sulphate plant.

On the other hand, product ammonia involves distillation of gas liquor or concentrated gas liquor, or mixtures of both, the passage of a steam-ammonia stream through the distribution pipes of a saturator, the ejection of the magma, the neutralisation and centrifuging of the acid-containing sulphate and its subsequent drying and discharge to the stores. The above table gives a comparison of the respective unit operations.

Economics of Ammonia Processes

From an economic viewpoint, units of synthetic ammonia plant may be of 100 tons up to 500 tons per day capacity. Few product ammonia plants are larger than 100 tons per day, and many are of a much smaller size.

Anhydrite is appreciably cheaper as a sulphate radical than the equivalent quantity of sulphuric acid. On the other hand, the various unit operations involved are likely to be more expensive in the case of synthetic than those involved in the manufacture of sulphate of ammonia from product ammonia.

Because the Liquor Effluents and Ammonia Committee of the Institution of Gas Engineers² has recently issued a fairly comprehensive report of their works over nearly

nine years, it may be concluded that its work is virtually at an end. Certainly, it has investigated most of the interesting problems which have arisen, and published an immense amount of really valuable information. The author⁶ summarised the position regarding product ammonia, and indicated the direction in which economical

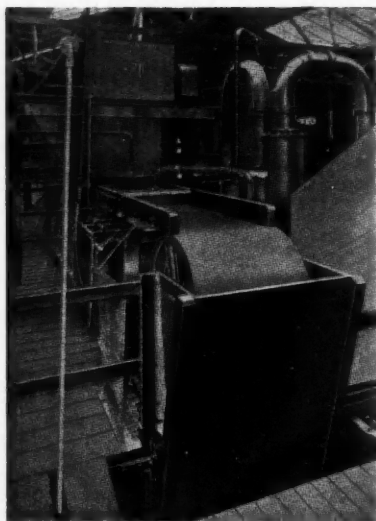


Fig. 1. Wilton's continuous extractor and vacuum draining equipment.

production could proceed. But the war years have superposed an additional economic burden and rendered the manufacture of sulphate of ammonia from product ammonia (even from concentrated gas liquor) unprofitable. Thus, it cannot be said that the product ammonia problem is solved: it is, indeed, more acute than in the crisis year of 1931, when the selling price of sulphate of ammonia was reduced, in July of that year, from £9 10s. to £6 per ton in August, but subsequently was raised by monthly additions to £6 15s. per ton in December, and to £7 per ton from January to June, 1932.

The only solution to-day involves an imaginative departure from the stereotyped. It means a demolition of old types of sulphate plants and the erection of new ones on a productive scale, far larger than has ever hitherto been contemplated. It also involves the manufacture, in part, of those ammonium products which are capable of realising the best unit price for ammonia.

Apart from the production of agreed quantities of anhydrous and liquid ammonia, it

should be a constituent of N.P.K. granular fertilisers, because the realisable unit-price of ammonia in this form is a marked improvement on the sale of sulphate of ammonia as such.

But the product ammonia problem is inextricably interlinked with the disposal of spent oxide, and the only way to dispose of any surplus material, assuming gas undertakings do not desire to change their existing methods of purification, is to arrange for it to be sold to central works, where the surplus sulphur can be used to manufacture sulphuric acid for the production of calcium superphosphate and N.P.K. fertilisers. If gas undertakings are willing to modify their methods, so as to recover sulphur as such by a method of liquid purification, or to produce spent oxide of greater purity, which, when extracted with carbon bisulphide, will yield sulphur suitable for employment at the contact sulphuric acid plants of the country, then the problem of the excess sulphur, which cannot be fixed with ammonia, because the ratio are disproportionate, may ultimately be solved. But immediate action is necessary, and the longer one waits, the greater will the problem become.

Manufacturing Grade I Sulphate

Where it is desired to manufacture grade I sulphate on a relatively large scale there is still doubt as to which is the more economical method for dealing with the magma from the saturators. Many large works believe that centrifuging in a Monel metal basket, neutralising the acid-containing bed of salt in the basket and drying subsequently in a shower type of dryer, is the better procedure. Certainly, neutralisation can be effected satisfactorily, and the salt can be dried to about 2 per cent water content before passing to the dryer proper. But the operation is an intermittent one, and six men are involved to deal with, say, 50/60 tons of sulphate of ammonia per day.

There is another school of thought which has been seeking continuity of operation, but have not found it in the Haubold type of centrifugal or in the Escher Wyss method. Mr. Norman Wilton (Chemical Engineering & Wilton's Patent Furnace Co., Ltd.) has pursued his efforts in the use of a continuous extractor and vacuum draining equipment (Fig. 1), and working in conjunction with a Midland works this equipment has been applied to a 60 tons per day sulphate of ammonia unit, and is giving satisfaction. The magma is discharged continuously to an extractor (a special design of vessel) and the mother liquor overflows through a weir to the acid charge pot. In this way the extractor contains sulphate of ammonia at a constant level, and this is withdrawn by a scraper device and discharged to the vacuum band, comprising a

slow-moving woven-wire stainless steel belt of very fine mesh, on which the sulphate is spread in an even layer about $1\frac{1}{2}$ in. thick. The vacuum belt travels at a speed of 8 ft. per min. and passes over a series of vacuum shoes which operate at about $4\frac{1}{2}$ in. mercury vacuum. A Waller's exhaustor is used for creating the suction, and barometric legs and a special device are arranged for avoiding the corrosive influence of the acid mother liquor which is withdrawn.

Operating in this way the moisture can be reduced to about 5 per cent, and an average tonnage of between five and six thousand tons can be treated before it is necessary to renew the belt. It may be remarked here that a Monel metal centrifuge, during its life, will deal with 40,000 tons of sulphate of ammonia, but of course in time the side sheets have to be reversed (top for bottom) and a certain amount of riveting and repair work is involved.

But the feature of a Wilton continuous extractor and vacuum draining equipment is that it gives the nearest approach to continuity of operation, and this, after all, is

phate of ammonia process. This book was hailed by the British Sulphate of Ammonia Federation at the time of its publication as one that would afford means to introduce marked economies in the manufacture of sulphate of ammonia. How far advantage has been taken of its suggestions it is difficult to say. In America it has been said that while it was excellent for the period 1924-34, its value has since declined. It is not proposed to comment on these observations, except to say that the implications of the chapter in question need to be applied, and if applied the economies effected would be of no mean order.

To be specific in this connection one should consider:

(a) The utilisation of the effluent liquor as the means of preheating the gas liquor or concentrated gas liquor.

(b) The partially-cooled effluent liquor should be fed to a low-pressure vessel (a kind of boiler), in which steam should be generated for the distillation units by submerged combustion methods.

(c) The steam, with H_2S and CO_2 , after

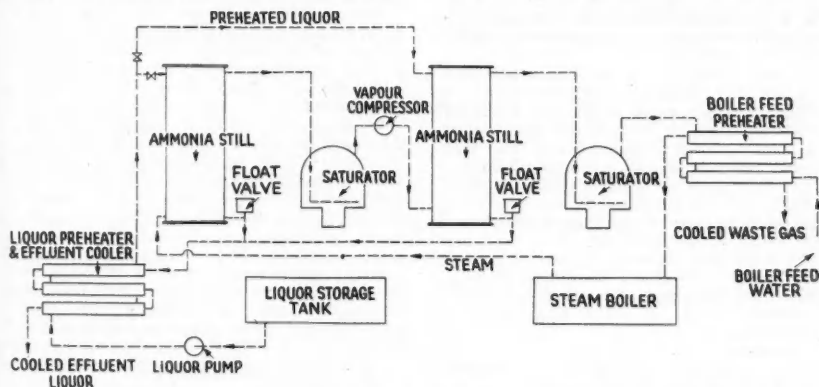


Fig. 2. Multiple effect system of distillation of gas liquor or concentrated gas liquor.

a desideratum. Thus, it is seen that one has to balance an intermittent operation involving slightly more labour, but giving a sulphate with 2 per cent of moisture, against a continuously operating arrangement entailing less labour, but giving a product with 5 per cent of water.

So far nothing has been said specifically about improvements in technique, except that the scale of operations must be sensibly larger than has hitherto been contemplated. No one appears to have considered—or if they have considered, have never acted upon—many of the interesting suggestions contained in chapter 9 of the author's book—“Design and Working of Ammonia Stills,” dealing with the thermal aspect of the sul-

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(c) The steam, with H_2S and CO_2 , after

absorption of the ammonia in the saturator, should pass to a compression pump and be used again for distilling further quantities of ammonia from gas liquor or concentrated gas liquor. Indeed, a number of multiple-effect distillations should preferably be arranged, as represented in Fig. 2. A marked economy in the consumption of steam would result from the adoption of this method. It should be noted that the foregoing schematic layout does not incorporate the principle of generating steam by submerged combustion. The latter method has now become possible because it is no longer usual to introduce cream of lime to gas liquor or mixtures of concentrated gas liquor and gas liquor, to release the fixed ammonia.

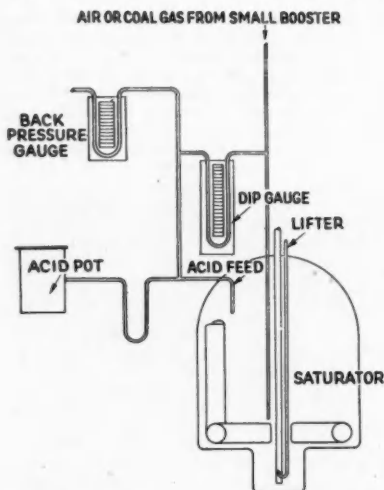


Fig. 3. Sulphate of ammonia saturator-seal indicator and back-pressure gauges.

(d) Provision should be made to drive all units of the sulphate plant with separate electric motors, instead of through a central steam-driven power unit, involving clutches and a multiplicity of countershafts and belt drives. For a 60-ton sulphate plant the power absorption should not be appreciably in excess of the following:

- (1) 1 h.p. for stirred agitator-drainer.
- (2) 6 h.p. for centrifuge.
- (3) 4 h.p. for elevator.
- (4) 4 h.p. for driving shower type dryer.
- (5) 3 h.p. for the band conveyer.

Total 18 h.p.

(e) An improvement of the throughput from the centrifuge by the introduction of a stirred drainer can be effected. In this way, the basket can be filled rapidly from the drainer and the time at present occupied in the filling of the basket by direct ejection from the saturator will be reduced appreciably.

(f) Production of hot water for radiators, etc., should be arranged by interchange of heat between softened feed water and the final steam, CO_2 and H_2S stream leaving the last saturator of the multi-effect arrangement of plant.

How can the efficiency of manufacture of product sulphate of ammonia be improved? This involves a critical examination of the existing losses arising from the present technique. The chief losses are: (1) ammonia in the effluent liquor; (2) ammonia lost in devil liquor; (3) sulphate of ammonia and

acid lost in leakages or spillages of mother liquor; (4) loss of sulphate during the discharge of the dry salt to the stores, and its loading to bags.

The advent of new shift-workers (ex-Service men) has revealed that ammonia losses may occur in the effluent gases from the saturator, largely because the operatives are not aware when the cracker pipes are inadequately sealed. Under certain circumstances the level of the liquor in the acid charge pot may give an erroneous indication of the level of the magma in the saturator, and if the seal is inadequate ammonia may possibly escape. Again, a saturator may be surcharged with crystalline salt, and ammonia may escape absorption by the acid for that reason.

It is an advantage to introduce at least 75 per cent of the acid on the surface of the bath, rather than to feed the whole of the acid via the acid charge pot.

Again, filtration of the mother liquor, and its circulation through the anti-entrainment boxes, is also to be desired as a means of arresting any final traces of ammonia that may escape absorption in the acid magma of the saturator. But the operatives should be provided with an indication of the depth of seal of the cracker pipes, and a device such as is represented in Fig. 3 is bound to be invaluable to the tyro, if not to the more experienced shift-worker.

What is still required is an electrical conductivity device for recording the acidity of the bath; better still, a device which will simultaneously record the acidity of the bath and adjust it, so that a predetermined figure of, say, 5 to 6 per cent H_2SO_4 is continuously maintained.

One could proceed to an interesting discussion relating to the control of the anhydrite process, in its various stages; but it is feared too much space has already been occupied, and these interesting observations must be reserved for another occasion.

Barium

The Geological Survey have recently issued a comprehensive report which brings up to date the geological, technical and production data on all the occurrences of barium minerals in England and Wales.⁶ Dealing with the general supply position, the authors consider that the outlook for witherite production is satisfactory, there being sufficient reserves to maintain supplies at their present level for at least ten years. As regards barytes production, adequate reserves are available for present needs, although it is suggested that experiments on the fluorination of lead-mine dump material and waste fines from gravity barytes mills would, if successful, substantially increase the domestic reserves of this material. The pre-war average ex-mine price of crude barytes was 27s. 3d. per ton,

but during the war this figure rose to as high as 70s. per ton. It appears that only because of this high price level has the economic working of some of the deposits been possible, and any considerable price reduction will certainly lead to a curtailment of production.

A plant for the production of barium chloride direct from barytes has been put into operation by Mettur Chemicals, Ltd., Mettur, India.⁹ The method used consists in fusing a mixture of barytes, charcoal and strong calcium chloride solution, leaching the reaction mass with water and crystallising. A coal-fired reverberatory furnace, provided with three distinct beds heated to 800-850°C., is used for the fusion, a reducing atmosphere being maintained by careful air control. Barytes and charcoal ground to 100 mesh is mixed with 50 per cent calcium chloride in the proportion 1.0 : 0.5 : 1.25, and charged into each of the three beds of the furnace at intervals of three hours. The reaction is completed in about six hours. The reaction mass is then withdrawn and lixiviated in vats heated by the waste combustion gases. Three lixiviations are made; the first two, varying in density between 18° and 20° Bé., are sent to a settling tank, while the third extract, of 5°-9° Bé., is used for lixiviating a fresh charge. The insoluble residue, containing calcium sulphide, is removed for the recovery of sulphur.

The first extracts are treated with lime, allowed to settle and decanted to a second tank, there they are treated with chlorine to destroy soluble sulphides. After settlement of the small quantity of precipitated sulphur the clear liquor, containing 320-380 gm./litre of barium chloride and 15-20 gm./litre of calcium chloride, is concentrated in cast iron pots to 38°-40° Bé. Barium chloride of 98 per cent purity is obtained by crystallisation at room temperature, but a pure product may be prepared by simple recrystallisation.

Electrolytic Chlorine

The demand for chlorine has been well maintained and many plants have been operating above their rated capacity. With rising labour and material costs the economic aspect of the process has assumed increasing importance and has led several investigators to study carefully the various factors which influence manufacturing costs. The three main items of cost are power, salt, and anodes, with power amounting to 60 per cent and anodes 10 per cent of the total. Under optimum load conditions anode consumption rates can be kept at a minimum, but with increasing loads the anode consumption is increased and thus becomes a major item of cost. The various factors which influence anode consumption have been reviewed by R. B. Hammond and N. J.

Johnson.¹⁰ The four primary cell operating factors influencing anode consumption which were the subject of investigation were (1) temperature, (2) brine feed rate (which is related to per cent NaCl decomposition), (3) anode current density, and (4) feed brine concentration. The results of the experimental work may be summarised briefly as follows:

(1) It was found that in the operating range from 50° to 95°C. the graphite corrosion rate increases approximately 1.2 gm. per 1000 amp./hr. per 10° rise in temperature. With 50°C. as a base, graphite attack increases 70 per cent at 60°, 210 per cent at 80°, and 310 per cent at 95°. At constant temperature and current density brine feed rate becomes a factor of prime importance.

(2) Zero corrosion is indicated for infinite rate of flow and 25 per cent g. 1000 amp./hr. (five times normal) is shown for 100 per cent NaCl decomposition, i.e., when the rate of NaCl input equals the rate of decomposition.

(3) Even a slight reduction of NaCl content of the feed brine from the point of saturation results in a significant increase in the rate of anode corrosion and this rises rapidly as brine concentration decreases.

(4) Expressed in terms of loss per 1000 amp./hr., graphite consumption decreases slightly with increased current density, but expressed as graphite consumption per unit time, the loss increases nearly linearly with rise of current density.

Interesting German Developments

Many interesting developments in German chemical technology have been revealed by the Allied investigations. In the alkali industry a new type of cell for chlorine and caustic soda has aroused particular interest. This cell, which was developed by I. G. Farbenindustrie A.G., is of the vertical rotating cathode type, and shows several advantages over the more conventional forms of construction. One of the main advantages is the comparatively small floor space occupied. The cell consists of a steel drum, 0.60 m. dia. by 0.5 m. wide, mounted on a horizontal shaft. This drum is provided with five circular cathode plates, arranged at right-angles to its axis. The drum and its plates are enclosed in a steel housing, which is split horizontally into three sections, flanged and bolted together. The top section has sloping sides, the middle section is roughly rectangular, and the bottom is curved to conform to the circular cathode plates. All but the bottom section are rubber-lined. The cathode assembly is rotated at approximately 7 r.p.m. by means of a 0.65 kW motor. Six sets of graphite anodes are supported from the cell housing, and these anode assemblies are split horizontally with a 20 mm. space to facilitate circulation of the brine. About 1300 kg. of mercury

fills the bottom of the cell to a height of about 2 cm. above the bottom of the rotor.

Purified and nearly saturated brine at 70°C. is fed through the housing at one end, just above the level of the mercury, and fills the entire housing above the mercury to within about 4 cm. of the top, where it overflows. The NaCl content of the brine is reduced from 310 to about 260 g.p.l. Chlorine gas leaves the cell by the overflow pipe and is later separated from the weak brine. The mercury amalgam is pumped from the cell to a vertical cylindrical decomposing tower packed with graphite. Distilled water is fed into the tower at the bottom and flows counter-current to the amalgam and the flow is so adjusted that the concentration of the emergent caustic soda is between 50 and 70 per cent. Hydrogen passes out from the same overflow pipe and is later separated from the caustic solution. The mercury, practically free from sodium, is returned to the cell.

At Hüls, where a large battery of these cells was in continuous operation from October, 1940, until the end of 1944, it was possible to gain some idea of operating costs. In this particular plant the losses were between 0.5 and 1.25 lb. mercury per ton of chlorine, and the carbon consumption was between 0.45 and 0.65 kg. per 100 kg. chlorine. Power consumption was 360 to 400 kWh per kg. of caustic soda. A later installation of cells at Ludwigshafen is of improved type, based on experience at Hüls, although they have not yet operated for sufficient time to establish complete data. They are, however, expected to give improved results.

Cyanogen Compounds

Among the many interesting BIOS reports which have recently been made generally available is one (No. 424) which describes the methods used at Bad Kreuznach for the manufacture of carbon bisulphide, thiourea and ammonium thiocyanate.

The thiocyanate process is a novel one, consisting of the autoclavic reaction of carbon bisulphide and 25 per cent ammonia. A jacketed mild steel autoclave of four metres capacity is used, capable of withstanding pressures up to 5 atm. The batch charge is 400 kg. of bisulphide, with sufficient ammonia to form ammonium thiocyanate and ammonium sulphide. The complete reaction takes 24 hours, during which time the temperature is gradually raised to 100°C., and at this point maximum pressure is reached. At the end of the reaction the pressure is reduced and the ammonium sulphide distilled at 100°C. This operation, which takes about 8 hours, is not carried to completion, since a little residual sulphide minimises corrosion of the autoclaves. The hot thiocyanate solution is filtered to remove iron impurities and run into mild steel crystallisers. The crude crystals so obtained are

redissolved and the solution concentrated in vacuum evaporators of aluminium construction at a maximum temperature of 80°C. Care is necessary not to exceed this figure, since at higher temperatures the ammonium thiocyanate is converted to thiourea. A final pure product is obtained by crystallisation in aluminium crystallisers. The ammonium sulphide is heated with lime to produce calcium hydrogen sulphide, which is sent to the thiourea plant, and ammonia, which is returned to the thiocyanate process.

Thiourea is produced by the reaction between calcium hydrogen sulphide and cyanamid. This reaction commences spontaneously, and does not require external heat. The reactants are mixed in cast iron pots and then transferred to closed mild steel vessels, where a temperature of 70°-80° is reached. The reaction is complete in about an hour. The resulting slurry contains thiourea and calcium trithiocarbonate, together with suspended calcium hydroxide, which is removed by filtration in bottom discharge centrifuges. Concentration of the filtrate is effected in jacketed mild steel evaporators fitted with stirrers, to keep the calcium hydroxide (which separates during the process) in suspension. Calcium trithiocarbonate is decomposed during concentration into calcium sulphide and carbon bisulphide. The concentrated solution is filtered to remove the calcium salts and thiourea recovered by crystallisation. Approximately 70 per cent of the total nitrogen entering the process is recovered as thiourea.

Another report (CIOS 22) describes briefly the methods employed by the I.G. at Oppau and Ludwigshafen for the production of hydrocyanic acid. The process is effected in three stages, viz. (1) the reaction between methanol and carbon monoxide to produce methyl formate, (2) the interaction of methyl formate and ammonia to give formamide, and (3) dehydration of formamide to produce hydrocyanic acid. The first two steps in the synthesis were carried out at Oppau, where approximately 850 tons of formamide per month was produced. This entire output was then dehydrated at Ludwigshafen.

Fluorine Products

In last year's review a brief account was given of the development of the fluorine products industry in the U.S.A. Considerable interest has again been shown in this subject and the American Chemical Society has devoted a large proportion of its annual proceedings to a consideration of a symposium on fluorine chemistry. Although the use of fluorine products has expanded with remarkable rapidity during the past ten years it is confidently expected that future development will be even more startling.

Organic compounds containing not less than two atoms of fluorine attached to a carbon atom are very stable and are, in

general, resistant to heat and chemical agents. Fluorohydrocarbons of very high molecular weight can be prepared, having vapour pressures approximating those of the present substances.¹¹

Preparation of Fluorine Compounds

The starting point for the preparation of these compounds is H_2F_2 , produced by the decomposition of fluorspar with sulphuric acid in rotary steel retorts. The second step is the electrolytic generation of fluorine and its purification and liquefaction. Cells of the diaphragm type are employed, having carbon anodes. No particular difficulties have been experienced in the construction of the cells. Ordinary carbon steel is used for the cell body, the hot water jacket and the hydrofluoric acid feed line, the cathode, and the solid portions of the diaphragm. The lower portion of the diaphragm is a Monel screen. Nickel has been used for the anodes, but in spite of its superior mechanical strength and insensitivity to polarisation and other undesirable effects, its corrosion rate is comparatively high and the corrosion products tend to contaminate the electrolyte. Carbon electrodes were originally difficult to operate, owing to frequent mechanical breakage and also because carbon polarises rapidly. The polarisation difficulties have been substantially overcome, however, by the addition of 0.5 to 1.5 per cent of lithium fluoride to the electrolyte, which consists of a fused KF-HF mixture. The cells operate at an optimum temperature of 105° . Current efficiencies of over 90 per cent have been obtained at 8-10 volts. The life of the anodes is approximately three months, diaphragm screens have a useful life of about a year, and the cathodes and cell bodies are good for several years' operation. Fluorine gas has been satisfactorily handled at ordinary pressures and temperatures in pipes and vessels of steel, nickel and Monel. In order to overcome difficulties of supply and demand it is usual to store the fluorine in tanks under pressure. Oil-operated diaphragm pumps have been developed for this purpose, which transmit pulsations hydraulically to a second fluorine pumping head through a pipe containing a highly fluorinated hydrocarbon, relatively inert to fluorine. The gas is usually stored at a pressure of 30 lb. per sq. in. The cell gas usually contains appreciable quantities of HF , together with small quantities of O_2 , CF_4 and CO_2 . Hydrofluoric acid has been satisfactorily removed by refrigeration. At -70°C . and at 1 atm. pressure the gas contains only 4 per cent HF , which can readily be removed by passage over sodium fluoride pellets.

The technique for catalytic fluorination¹² has been developed to such an extent that high yields of a desired saturated fluorocarbon may be obtained by the reaction of the

corresponding hydrocarbon with elemental fluorine. The reactants are diluted with nitrogen and then mixed gradually in the presence of fine copper turnings coated with a thin layer of silver fluoride, at temperatures of $140-325^\circ\text{C}$. This method has been used to produce straight or branched chain fluorocarbons ranging from perfluorobutane to perfluorohexadecane and naphthenic fluorocarbons from C_6F_{12} and $\text{C}_{10}\text{F}_{18}$. Another method of fluorination makes use of cobalt trifluoride as a catalyst. This compound is produced by the fluorination of anhydrous calcium chloride in two steps: treatment with gaseous hydrofluoric acid at $350-450^\circ$ and fluorination of the resulting CoF_2 at $200-300^\circ$. Hydrocarbon vapour, diluted with nitrogen, is then passed over the bed of CoF_2 at $200-300^\circ$. Many completely fluorinated compounds have been made by this method, which shows great promise for commercial development.

Other interesting processes include the preparation of sulphur hexafluoride by direct synthesis through the action of fluorine upon molten sulphur and the liquid phase oxidation of organic compounds by the use of HF at temperatures below 200° with molecular oxygen as the agent. Experimental work has indicated that a method has been established whereby ring oxidation, in preference to side-chain oxidation, can be accomplished and that ring splitting can be avoided.

The heat of combination of F and H_2 is approximately twice that of H_2 and O_2 , and this fact has been utilised in the development of a method of welding copper, nickel and Monel. An intense bluish-white flame is produced by combustion in a torch of the concentric tube tip-mixing type and the welding operation is further simplified by the fact that the copper fluoride melts at a lower temperature than copper and the welding is therefore self-fluxing.

Germanium

Important new uses have recently been found for germanium metal and its dioxide and as a result of production on a commercial scale it is expected that future development will considerably increase its sphere of application. The present demand for germanium arises from its use in radar, from its exceptional properties as applied to film resistors, and from the remarkable characteristics of alloys which expand slightly on cooling. These alloys are employed in small-scale precision castings, e.g., the binary Au-Ge eutectic is used in dental inlay work. Sources of germanium include the sulphide, Germanite, and the oxide known to occur in Britain and Russia to the extent of about 1 per cent in coal ash and flue dust. The Eagle-Picher Company of America, which developed an industrial-scale process in response to radar demands, are reported

to be the world's largest producers at present. Germanium was found to be concentrated in the fumes produced in sintering zinc concentrates. This fume is dissolved in sulphuric acid and after separation of other metals, notably cadmium, the greater part of the germanium is concentrated in certain residues. These residues, distilled with excess HCl, form GeCl_4 , which is subsequently treated to produce pure tetrachloride. Germanium hydroxide is then prepared by hydrolysis, which is washed, filtered and dried at 150°C . to form the dioxide. Finally, reduction of the dioxide with sodium cyanide and carbon at 1200°C . yields a metal of 99.6 per cent purity.¹³

Magnesium

The production of pure magnesium from dolomite by the Pattinson method has been the subject of a detailed investigation by the U.S. Bureau of Mines. The usual process consists in leaching lightly calcined dolomite in water charged with CO_2 under pressure and then boiling the leach liquor to precipitate basic magnesium carbonate. As a result of the U.S. investigations means have been found to eliminate the necessity for autoclaves and a continuous process, operated at normal temperatures and pressures, has been evolved. Dolomite can be selectively calcined in an atmosphere of CO_2 to yield MgO and CaO . Selective calcination requires less heat than complete calcination and yields a product from which the maximum quantity of MgO can be leached with minimum CaO content and with minimum consumption of CO_2 . Electrically-heated multiple hearth furnaces, or externally fuel-heated muffle furnaces are indicated, so as to obtain the undiluted CO_2 necessary for efficient leaching. This operation may be accomplished in turbo mixers during a treatment period of approximately one hour. The resulting slurry, containing 2 to 3 per cent of solids, should be filtered rapidly, so as to avoid loss of MgO from the supersaturated bicarbonate solution by precipitation. Magnesium carbonate may then be precipitated from the filtrate by heating to about 59°C ., and then passing air through the warm solution. Although the precipitate is voluminous, it is crystalline and easily filtered. The wet precipitate must be dried and calcined in such a manner that the CO_2 can be collected without dilution by air. Material and energy balances have been prepared for the process, which appears to be a relatively inexpensive method for the manufacture of high-grade MgO in units of large capacity.¹⁴

An interesting report on the German magnesium industry has been published.¹⁵ At the end of August, 1945, about 154,000 lb. of metal were being produced per day at the I.G. works at Bitterfeld, Stassfurt and

Aken. The ferrosilicon process was tried, without much success, and an experimental carbon reduction (Hansirg) unit also gave negative results. The raw materials for the electrolytic process used at the Bitterfeld works were carnallite and high Mg content dolomite. The dolomite was calcined at the quarry and slaked with 26 per cent MgCl (an end product of the potassium-chlorine operation from carnallite). The precipitated $\text{Mg}(\text{OH})_2$ was washed, dried and calcined at 900°C ., and the MgO then mixed with $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ to give a product called oxychloride. This material was next mixed with coal and peat and then briquetted, calcined and finally chlorinated in large vertical cylindrical chlorinators. Molten magnesium chloride leaving the chlorinators was transferred to crucibles and fed to the cells at eight-hour intervals. The total chlorine addition amounted to 1.98-2.48 lb. per lb. metal. The cells operated at a current density of 4.3 amp. per sq. in., the power required being between 8 and 8.5 d.c. kWh per lb. of metal. Anode consumption was of the order of 0.025 lb. per lb. magnesium. Labour figures for the cell room, including repairs and maintenance, were given as 37.3 man-hours per ton of metal.

Considerable interest has recently been shown in the anodising of magnesium alloys as a means of providing a corrosion and abrasion-resisting surface. The coating produced by such means is tenacious, sensibly harder than the metal and it affords protection even during forming operations and during the assembly of parts.¹⁶

Sodium

During the past few years metallic sodium has found increasing application as an industrial raw material. Many of the uses of sodium are well known, but it is none-the-less a surprising fact that during the war years the world production of the metal exceeded that of tin.¹⁷

One of the most important uses of sodium is in the manufacture of tetraethyl lead. Although only 0.04 fluid oz. of tetraethyl lead is used in each gallon of motor fuel, the total consumption of sodium absorbed in its manufacture amounts to millions of pounds annually. Indeed, the demand for tetraethyl lead during the war, for use in aviation petrol, led to the curtailment of supplies of both lead and sodium for most other purposes.

Another important user of sodium is the sodium cyanide industry, and further large quantities of the metal are absorbed in the preparation of sodium peroxide. Many pharmaceutical chemicals, including the barbitol series, are derived from syntheses involving the use of sodium. One of the most recent applications of sodium is a process described by the Du Pont Company¹⁸ for the descaling of alloy metals. The new process,

which avoids loss of the base metal, involves the use of a caustic soda bath maintained at a temperature of approximately 700°C. The bath contains about 2 per cent sodium hydride, formed by the action of hydrogen on metallic sodium. This small proportion of sodium hydride converts the scale to loosely-adherent metal and leaves caustic soda as a by-product of the reaction.

Among the mechanical applications, mention should be made of the increasing use of molten sodium as a heat transfer medium. The sodium-cooled valve has been described as the greatest single step towards improved aircraft engine performance. Practically all aircraft engines of over 300 h.p. have sodium-cooled exhaust valves, while in America sodium-cooled intake valves have also been used on high-output engines. The hollow interior of a steel valve is partly filled with sodium, which melts when the engine becomes warm. The sodium is agitated by the valves' movement, and carries the heat through the valve stem to the cooling system. Sodium also possesses a high electrical conductivity, and this property has found practical application in the use of wires having sodium cores covered with copper.

Sulphuric Acid

The raw materials used in the manufacture of sulphuric acid in this country in 1945 were as follows:

	Tons
Pyrites and others	277,920
Spent oxide	187,644
Brimstone and H_2S	160,061
Zinc concentrates	149,461

The annual plant capacity of the United Kingdom, including government plants, based on 100 per cent acid, was approximately 1,600,000 tons. The extent to which plant capacity was utilised was about 72 per cent.

It is appreciated that during the war years the urge was to manufacture sulphuric acid, despite the fact that repairs or renewals were called for. Production, in those days, was the essential consideration. With the cessation of hostilities, naturally, a period of repairs or reconstruction has been entered upon, much of the embarrassment of the fertiliser and other industries, which were anxious to increase their production of calcium superphosphate, etc.

Many manufacturers in this country are wedded to the use of brimstone of American origin, and have no second string to their bow, in that the contact plants which they have erected and operate have been designed essentially for the combustion of brimstone, and do not lend themselves to the adoption of pyrites or other sulphur materials.

On the continent sulphuric acid manufacturers seem disinclined to place all their eggs in one basket; they prefer that their acid plants shall be designed in such a way

that alternative raw materials are available. They recognise that it is unwise to be left without means for negotiating their contracts for the purchase of sulphur materials.

At the present time one can understand that the British Treasury are not too anxious to purchase American sulphur, because dollar-sterling exchange is involved. One would like to see the sulphur of spent oxide displacing brimstone at many of the contact sulphuric acid plants, but the use of this material for the purpose in question still constitutes an unsolved problem. It should be possible for the gas industry to establish a case for the employment of spent oxide in substitution for brimstone. It is the London area which is responsible for the major surplus of spent oxide at the present time. In London and eastern counties the consumption in 1938 was 35,961 tons, and the production was variously estimated at between 68,000 and 79,000 tons. In 1944 the consumption was 40,746 tons, and the production variously estimated at 66,800 to 77,500 tons.

The gas industry may desire to consider the recovery of cyanogen and benzole before the oxide of iron purifiers. Working thus, relatively pure sulphur could be extracted from the spent oxide by carbon disulphide and this sulphur could be sold to contact sulphuric acid manufacturers at a price affording some advantage over the purchase of American sulphur. It is known that certain coke-oven recovery plants are operating in this way, without any apparent disadvantage as regards the quality of the benzole recovered. The oil-benzole ratio may be slightly affected, due to the recovery of tarry vesicles.

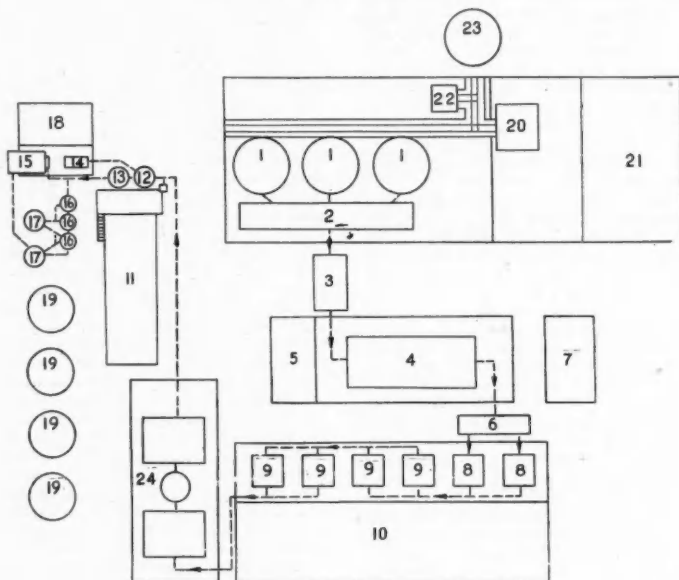
Mr. Robson¹⁹ has observed that the question of using spent oxide in contact plants was a very intricate one. Spent oxide was not a simple material by any sense of the term, but he was quite sure that if subjected to research, the question of using spent oxide economically in a contact plant would be solved. Perhaps the recovery of sulphur in the way suggested is one tangible solution.

Complications in Production

When one considers what complications are involved in the production of contact sulphuric acid from arsenical pyrites, one can understand why British manufacturers have exercised a preference for brimstone. Nevertheless, arsenical pyrites are being used as the raw material for contact plants on the European continent, and it is interesting to examine Fig. 4, which indicates diagrammatically the type of plant adopted in the production of contact sulphuric acid from arsenical pyrites.

The legend makes clear what the plant comprises. Harris mechanical pyrites burners have been adopted in this case, be-

Fig. 4. Layout of a Contact Sulphuric Acid Plant, Using Arsenical Pyrites as the Raw Material.



- | | | | |
|---------------------------------------|---|--------------------------|--------------------------------------|
| 1. Rotary Mechanical Pyrites Burners. | 7. Instrument and Apparatus Room. | 11. Coolers. | 19. Acid Storage Tanks. |
| 2. Collecting Flue. | 8. Glover Towers. | 12. Drying Tower. | 20. Storage Hopper. |
| 3. Gas Cooler. | 9. Scrubbing Towers for Removal of Arsenic Oxides, etc. | 13. Absorption Tower. | 21. Pyrites Store. |
| 4. Electrostatic Dust Precipitator. | 10. Storage Tanks, Pumps, Coolers, etc. | 14. Blower. | 22. Lift. |
| 5. High Tension House. | | 15. Starting-up Furnace. | 23. Pyrites Cinders Bin. |
| 6. Collecting Flue. | | 16. Heat Exchangers. | 24. Electrostatic Mist Precipitator. |
| | | 17. Converters. | |
| | | 18. Control Room. | |

cause they ensure satisfactory combustion of the pyrites, with a minimum creation of dust, and they are of substantial construction, equipped with a special alloy steel such as high chromium steel, ERA.H.R.41, for the rabbles, and nickel-chrome tungsten steel, ERA.C.R.2, for the arms. As the temperature of the gases leaving the collecting flue is likely to be of the order of 650-700°C., a steel atmospheric cooler is provided in order to reduce the temperature of the gases at the entrance to the electrostatic dust filter to 525°C. The dust-free gases are discharged into a collecting flue, and pass through an electrostatic dust precipitator, thence to a Glover tower, afterwards to special scrubber towers (the method of operating which is indicated later). The gases emerge deprived of iron oxides, arsenic oxides, lead sulphate and halogens, and pass through an acid mist precipitator, thence to a drying tower, through heat exchangers to the converters and thence to the absorption plant, for the production of 98

per cent H_2SO_4 , or other strengths of acid, as may be required.

It is estimated that the cost of purifying burner gases, involving the removal of iron oxide dust, arsenic oxides, lead sulphate and halogens, is of the order of 5.47d. per unit. This figure is arrived at in the following manner:

	£
Estimated extra cost of mechanical burners and equipment, over brimstone burners	10,000
Extra cost of burner-house and equipment	1,500
Gas cooler	750
Cost of electrostatic precipitator	7,000
Building for the above	1,500
Wash towers, coolers, decantation tanks, circulating pumps, etc.	12,000
Acid mist precipitator, humidifier, connections and buildings	13,500
	<hr/> 46,250

Thus, the operative charge per year will be as follows:

	£
4 per cent interest on capital, namely, £46,250	1850
10 per cent for repairs and renewals	4625
Estimated yearly operating costs	1500
	<hr/>
	7975

30 tons of monohydrate sulphuric acid per day is equivalent to:

- (a) 10 tons of sulphur per day, or 1000 units of sulphur.
 (b) 1000 units of sulphur \times 350 days/year = 350,000 units sulphur/year.
 (c) £7975 represents the yearly operative and on-cost charges = 1,914,000d.
 1,914,000d.

(d) $\frac{350,000 \text{ units sulphur}}{350,000 \text{ units sulphur unit of sulphur, as representing the cost of purifying the gases arising from the combustion of pyrites and rendering them suitable for conversion to SO}_2}$ = say, 5.74d. per

Apart from the above, the overall efficiency is not likely to be more than 89.00 per cent of saleable non-arsenical acid, plus say 2.5 per cent of relatively weak arsenical acid. The foregoing compares with an over-all efficiency, where brimstone is the raw material, of 96.5 to 97 per cent.

Efficiency of Combustion

Perhaps it will be asked: How is the overall efficiency as regards the arsenic-free strong sulphuric acid assessed? In this connection it should be noted that pyrites of the quality under discussion rarely contains more than 46.5 per cent of sulphur, and it is difficult to reduce the expungeable sulphur in the pyrites cinders to below 2.5 per cent. Thus, the efficiency of combustion is as follows:

	per cent
Expungeable sulphur content of original pyrites	46.50
Cinders represent 15 cwt. per ton of pyrites burnt	
Content of sulphur in cinders = 2.5 per cent.	

Therefore, loss of sulphur is

$$\frac{2.5}{1} \times \frac{15}{20} = 1.875$$

Sulphur burnt to SO₂ 44.625

Therefore, combustion efficiency is

$$\frac{44.625}{46.500} \times 100 = 95.86 \text{ per cent.}$$

The conversion and absorption efficiency can be assumed to be 96.5 per cent, giving an overall efficiency of 92.50 per cent. But relatively weak arsenical acid arises, representing 3.5 per cent. While some use may

be found for this, the actual recovery of arsenic-free strong acid cannot very well exceed, say, 89.00 per cent.

It should be noted that the loss of 3.5 per cent is influenced by the moisture content of pyrites, by the saturation of the atmosphere and the degree to which the gases from the primary section of the mist precipitator to the second section have to be humidified. The burning efficiency is governed by the uniformity of the size of the pyrites, and their freedom from decrepitation. Again, certain temperature conditions must be observed on specific shelves of the burners, or otherwise clinkering may occur, and this affects the efficiency of combustion. Other factors not usually fully appreciated enter into the question, e.g., the temperature obtaining in the second and third hearths of a mechanical pyrites burner are influenced by the degree of fineness of the pyrites. Not infrequently, high local hearth temperatures result from the combustion of an excess of very fine pyrites. It is for the foregoing reason that the screen analysis of the pyrites is highly important, and it is equally important that managements should see to it that the actual pyrites delivered accord with the screen analysis which is the basis of the contract. Experience suggests that the following screen analysis combines three essential conditions:

100 per cent through $\frac{1}{2}$ -in. mesh screen (i.e.,
 90 per cent through 3-mesh screen (i.e.,
 $\frac{1}{4}$ -in. openings):

Tolerance, 10 per cent on oversize:

Undersize, not more than 12 per cent
 through 100 mesh screen.

Main Considerations

The question may be asked: What are the main considerations to which attention should be given in obtaining a high degree of efficiency in operating a contact sulphuric acid plant, where arsenical pyrites is the raw material?

(1) Ensure best possible combustion by suitable control of temperatures of the respective hearths, by delicate air adjustment and by analysis of the content of the expungeable sulphur in the pyrites fed and the cinders discharged from the furnace. Careful screening of the pyrites to be undertaken to ensure that too much fines are not being delivered with the pyrites. Fusion point of pyrites to be determined and extra air-cooling arms used in the second and third shelves, if necessary.

(2) Adopt continuous SO₂ recorders so as to maintain the SO₂ content of the burner gases at a predetermined figure of, say, 7 per cent SO₂.

(3) Special care should be given to the cooling of the gases prior to admission to the electrostatic dust precipitator. The temperature on entrance to the latter should not exceed 525°C.

(4) Control should be exercised to ensure the maintenance of an optimum voltage at the electrostatic precipitator for the efficient deposition of the dust. Periodic rapping of the tubes and efficient removal of the dust should be provided for.

(5) Burner gases should be examined by a continuous test, so as to determine the efficiency of the removal of the dust.

(6) Countercurrent washing for the removal of the traces of iron oxide, arsenic oxides, lead sulphate and halogens, should be under strict chemical control. Water free from halogens should be used in the final towers and the acid wash will gradually increase in strength as this is circulated to the first Glover tower, which receives the burner gases of greatest impurity.

(7) Decantation of the circulating acids should be arranged, and a special cooler should be installed in connection with the Glover tower, to ensure that the acid circulated is of suitable temperature. All decantation tanks and stock cisterns (top and bottom) should be suitably enclosed and draughted, so as to remove any SO_2 that may be evolved.

(8) The chemist in charge should be familiar with the conditions under which crystallisation of the arsenious oxides in acid occurs. Below are given the solubilities of As_2O_3 in acid of varying strengths:—

Specific Gravity of Acid	Grams As_2O_3 /100 gm. Acid at 17°C.
1.000 (water) ...	1.80
1.020 ...	1.70
1.080 ...	1.55
1.125 ...	1.40
1.200 ...	1.00
1.250 ...	0.80
1.315 ...	0.50

(9) Cool the gases led into the multitubular coolers to, say, 30°C. before admission to the first portion of the electrostatic mist precipitator.

(10) Ensure suitable humidification of the burner gases prior to introduction to the second portion of the mist precipitator.

(11) Finally, arrange for the drying of the burner gases with strong sulphuric acid before introduction to the preheaters and catalyst chamber. A suitable anti-entrainment device must be adopted for preventing entrained acid reaching the preheaters and catalyst chamber.

Points to Watch

Many other aspects call for careful attention. Prevention of blockages in the Glover tower; a spare Glover tower should always be available; in operating the Glover towers there should be systematic cleansing and an adequate number of tanks for sedimentation; only pump to the top circulating tanks supernatant weak acid.

It will be clear from the foregoing indications that the manufacture of contact acid

from arsenical pyrites is a much more complicated and delicate operation than what is involved in the manufacture of contact acid from brimstone.

Concern has been evinced by the Chief Alkali Inspector²⁰ about the escape from contact sulphuric acid plants, when compared with that arising from the chamber process.

It is possible to start a chamber process *de novo* by adopting a given technique, and to ensure that sulphuric acid is made immediately following the charging of the sulphur material, without exceeding 1.5 grains SO_3 /cu. ft. Further, such a plant can work uninterruptedly for three-and-a-half to four years. Usually, the renewal of a burner pipe is the sole cause for arresting the continuity of the process.

On the other hand, one finds that some contact plants in this country are out of action once or twice a year for some reason or other, and this consideration must surely give one to think before lightly embarking on this process, especially when a price advantage is obtainable by the adoption of certain sulphur materials not usually available for the contact process. It cannot be doubted that the adoption of multiple converters, say, three in number, involving the use of more catalyst, would improve the conversion efficiency, although it is appreciated that the problem is surrounded by chemical engineering, physico-chemical and economic considerations, that need to be correlated and set out clearly. In any case, one cannot justify pollution of the atmosphere in these days, nor can one hope to fulfil requirements by creating another effluent difficulty.

Possible Innovation

The day may be not far distant when sulphuric, hydrochloric and nitric acids and superphosphate factories may desire to adopt methods for the continuous determination of their various escapes. Any such innovation would be in consonance with the current and rapid advance in scientific and technical development. Continuous determinations of escape would certainly afford a better indication of the losses at the chimney shafts or exit pipes of the various plants and would, no doubt, lead to greater efficiency. No modern and well-equipped works would desire to urge any possible objection to the examination of these continuous charts by the Alkali Inspector, who would still continue to visit works as at present, and introduce the element of surprise which is one of the chief features of such visits. Incidentally, he would presumably continue to take his snap tests, as a comparison with the continuously-recorded ones.

The continuous measurement of the acidity of the gases escaping from sulphuric acid plants has been in operation for more than ten years. Thus, a good deal of practical information has been accumulated. The

electrical conductivity of solutions of hydrogen peroxide containing small percentages of sulphuric acid is a linear function of the percentage of sulphuric acid. Investigations with mixtures of nitric and sulphuric acids have revealed that within reasonable limits of error, the total acidities of such mixtures as would result from the absorption of a mixture of oxides of nitrogen and sulphur in hydrogen peroxide should be represented by the equivalent acidity of sulphuric acid solutions. Expressed in another way, the acidity equivalent to the electrical conductivity of the hydrogen peroxide solutions agrees closely with the acidity as determined by the Fletcher bellows test. Thus, there remained the difficulty of oxidising nitric oxide to nitrogen peroxide, while the gases were in contact with the absorbing solution. Various methods of accelerating the rate of

oxidation have been examined. This subject was dealt with in some detail by H. D. Greenwood²¹.

Much experience has been gained with the continuous measurement of acidity of gases escaping from sulphuric acid plants since the publication of the contribution in question. Recently, the apparatus (Fig. 5) has been evolved. This comprises the following:—

A—Source of water to work the syphons, which operate both gas and liquid pumps.

B—Weir to ensure a constant head.

C—Inlet to the pump system.

D—Syphon operating the cycles of pumping through.

E—Gas burette, and its valve.

F1 and F2—Aspirating gas through.

G—Absorber, connected to the source of supply of gas to be analysed at

H—Inlet of the absorber.

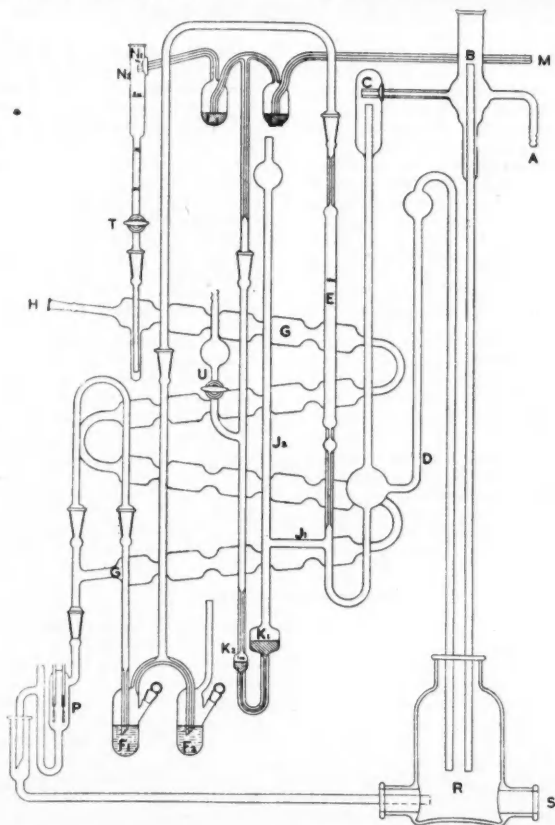


Fig. 5. Apparatus for Continuous Acidity Measurement of Gases.

Connected to the gas burette, E, is J1—a connection linking the hydrogen peroxide pump.

K1 and K2—Through its valves.

L1 and L2—Drawing their hydrogen peroxide from a Mariotte bottle (not shown), which is kept at a slightly negative pressure, the hydrogen peroxide being discharged via

N1—Into the feed tube and

N2—Verifying pipette, connected to the front of the absorber.

The acidic solution so prepared leaves the absorber G and enters P—conductivity cell, where its value is determined in grains of SO_2 per cubic foot.

Apparatus Synchronised

With the new design of apparatus a much smaller quantity of water is used. The measurement of the gases aspirated and the feed of hydrogen peroxide are in unison. With the original apparatus the feed of hydrogen peroxide and the gas measurement were independent and they could be out of step, if either source failed.

Soon a synchronous motor will be used, and this will dispense with the use of water for aspirating purposes. Invariably, the apparatus has to be disposed in a tower house 65 ft. or so from ground level, and it is no easy matter in any district to obtain a uniform and adequate town's water pressure.

With the new apparatus there will be a marked economy in the use of hydrogen peroxide.

There are other methods of determining acidity, which have been developed by the

central electricity generating stations. These depend on the addition of barium chloride and oxidation of the barium sulphite to barium sulphate. By means of a photo-electric cell, one measures the transmission of light through it and the acidity is a function of the turbidity of the solution.

In America, water-cooled towers are becoming popular in lieu of chambers for sulphuric acid manufacture.

In England and on the European continent an increasing number of "Parrish" liquid phase plants have been installed. Five units of rectangular chambers have been divided at one important works on the continent, so as to form tower chambers. These have been provided with turbo dispersers: indeed, thirty-five turbo dispersers will soon be operating at this works, and the increased production from the modifications indicated will be of the order of 30 per cent.

The "Parrish" turbo disperser has been improved in design. It is subject to special balancing and a special test, in order to determine that it is free from the slightest vibration. Moreover, the adoption of the Kestner glandless JPS1 pump has enabled the establishment of an acid circulatory system in connection with the turbo dispersers, which is free from difficulty. Indeed, it is foolproof and practically carefree. This apparently incredible achievement can be attested by reference to many important factories which have now adopted the acid circulatory system shown in Fig. 6.

The cost of chemical sheet lead has increased enormously (now £69 per ton), and

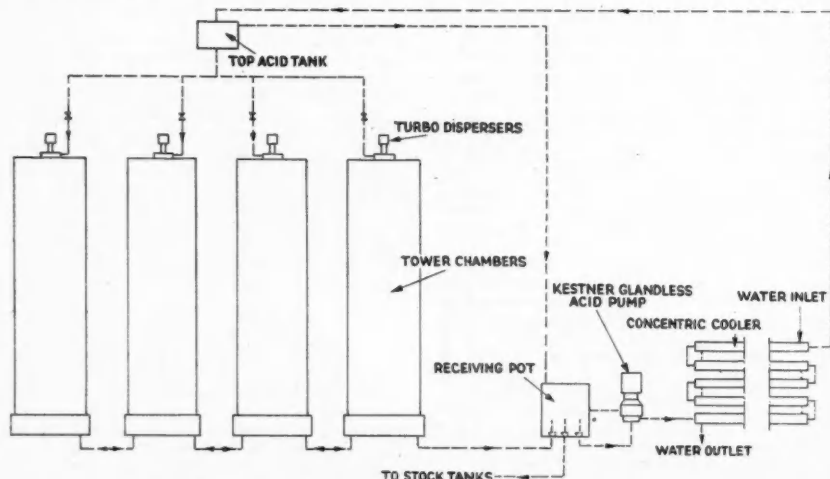
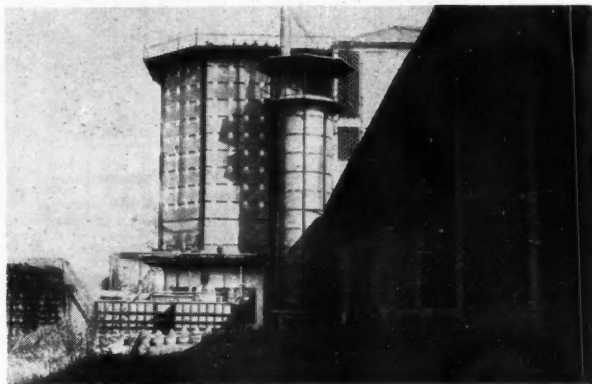


Fig. 6. The Parrish Liquid Phase System. Acid Circulating System for Supply to Dispersers.

Fig. 7. A view of the K.C.P. Sulphuric Acid Plant, with a Capacity of 30 tons.



as timber and steelwork are difficult to obtain, one obviously looks to new methods of construction involving new processes in order to circumvent the high costs inevitable in such constructional materials as steel, timber and chemical sheet lead.

The K.C.P. largely avoids high-price constructional materials and at the same time combines novel features which will, doubtless be of considerable interest to readers.

(1) The production of sulphuric acid is appreciably intensified. Thus, the reaction space and the initial cost of the installation are reduced.

(2) The arrangement of plant is modified, as compared with the established chamber or tower systems, chiefly in the following respects: (a) The Glover tower operates only as a denitrator, and does not concentrate chamber acid; (b) Gay Lussac towers as such are not employed; (c) The absorbing system is simplified, and involves, in principle, a single equipment, generally arranged in compartments.

Thus, the K.C.P. plant (Fig. 7) embraces: (i) Burners for the production of SO_2 ; (ii) A denitrating tower; (iii) An absorbing system, comprising one or more compartments.

(3) The process being super-intensive, it is possible to treat in the plant in question gaseous SO_2 of variable concentrations.

(4) The denitrating tower serves only for the purposes of denitration. Cold gaseous SO_2 can be used.

(5) For the reason indicated under (4), the hot gaseous SO_2 can be used for the concentration of sulphuric acid. Indeed, 40 to 50 per cent of the total acid can be produced as 166° Tw. acid (92.5 per cent H_2SO_4).

(6) The feed acid is of uniform composition in all compartments of the absorbing system, and thus only one pump is involved.

(7) The circulating acid is usually higher

in strength than 150-151° Tw. The coolers and piping can be of cast iron, thus reducing the cost of the installation (see Fig. 8).

(8) The method of operation is simplified.

(9) The conversion of SO_2 to sulphuric acid is generally above 99 per cent.

(10) The cost price of sulphuric acid is sensibly reduced, compared with the normal type of installation.

The method of working is as follows: Gaseous SO_2 from which the dust has been removed is introduced to the denitrating tower, fed with nitrous acid arising from the absorbing system, and is mixed with a predetermined quantity of water to reduce the initial concentration. The denitrated acid represents the final product, and its concentration is 142° Tw.

After passing through the denitrating tower, the gaseous SO_2 is led to the absorbing system, constituted of a single or several compartments. The gas is washed intensively by the "nitrous" acid in circulation. The SO_2 , under the influence of the action of N_2O_4 , is converted at a rapid rate to sulphuric acid. The water necessary for the reaction is introduced to the system.

The reactions are regulated in such manner that the absorption of SO_2 is completed at the same time that oxides of nitrogen are regenerated. The emerging gases contain only traces of SO_2 and NO .

The heat of reaction is removed by cooling in cast-iron coolers.

Where it is desired to recover part of the sulphuric acid at a concentration of 166° Tw., a concentrating tower is interposed between the dust chamber and the denitrating tower. The concentration is effected by evaporating the requisite quantity of water.

Professor R. G. Stapledon has said that "The agricultural problems before us are

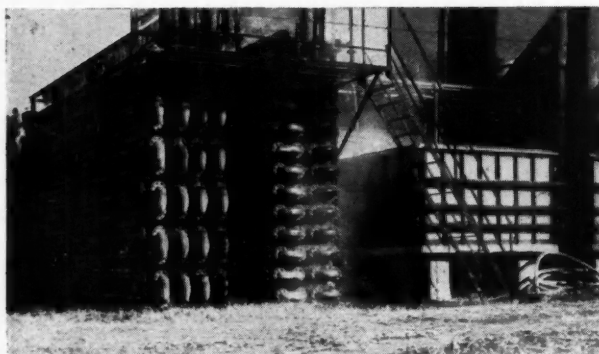


Fig. 8. Another view of the K.C.P. Sulphuric Acid Plant, Showing the Serpentine Coolers and Tanks.

frightening in their magnitude." That there are many problems to be solved cannot be doubted. It is not often emphasised that agriculture is the largest single industry in Great Britain. In 1931, the year of the last pre-war census, it will be found that the figures for the employment of men, and the value of the products, were as follows:

	Men	Value
Agriculture ...	1,194,000	£285,000,000
Coal-mining ...	1,166,000	
Cotton ...	591,000	} £179,000,000
Wool and worsted ...	248,000	
Iron and steel ...		£281,000,000
Chemical Industries ...		£194,000,000

Since the outbreak of war the value of products from the soil of Britain has increased appreciably, representing something of the order of £600 millions. British agriculture to-day is in a position to spend not only more than most industries, but when raw materials such as feeding stuffs and fertilisers can be imported, the rural population will buy on a bigger scale than ever hitherto. The Rt. Hon. Richard Law has estimated that the world needs something approaching 20 per cent more food than was grown before the war. The production of such things as meat, milk, fruit, and vegetables must be increased by from 100 to 200 per cent, as contrasted with pre-war figures. This involves more buying, and indeed more selling, by the primary producers. To meet the food needs of the peoples of the world there must be a vast expansion of agriculture and this will call for the application of the most advanced scientific and technical methods. Here is an opportunity alike for the scientist, chemical engineer and the technician.

Fertility and the Soil

If soil is to maintain its fertility it is clear that it must be suitably fed. Generally speaking, nutrients are of two kinds: one for plant growth, carbon dioxide, arising from the atmosphere is absorbed through the

leaf system, and water, derived from rainfall by absorption of the soil's moisture by the roots. In addition, there are a number of chemical elements which are absorbed by the plant, e.g., nitrogen, phosphorus, potassium, calcium, magnesium, boron, manganese, iron and sulphur, and obviously, the regular replacement of these is a necessity. None of the latter elements is needed in such quantity as say carbon: yet some are required in sensible quantity, while the rest are needed in insignificant or trace amounts.

It is clear that soils need what plants need. Most plants can grow and develop without soil, by allowing the roots to absorb by osmosis the nutrient constituents which are added and dissolved in water. In ordinary soil cultivation the various nutrients are absorbed by the root systems from the soil, or from the soil and whatever may be introduced to it.

Now the value of humus, the dark and complex product derived by the decomposition of organic matter, resides in its ability to retain moisture and to afford certain physical attributes to the soil. If soils are to promote growth they must retain moisture, and this is one of the essential functions of humus. Humus becomes depleted, just as the inorganic constituents of the soil become depleted. As the nutrients can only be absorbed from the soil solution, it is obvious that a satisfactory humus content of the soil is a *sine qua non* of nutrient absorption. In view of the foregoing fundamental considerations, one cannot but deprecate the popular idea of the last four or five decades, of associating fertility almost exclusively with fertilisers and plant nutrients, without emphasising adequately the necessity for humus. Nothing is calculated to render fertilisers so ineffective as an absence of humus, which gives satisfactory qualities to the soil and at the same time retains, during dry periods, the moisture so necessary for bringing into solution the nutrient constituents which are absorbed by the root system.

On the other hand, one must deplore the equally mistaken attitude of one school of thought, which wages a fierce attack against soil scientists of wide experience and orthodox views, on the ground that they seek to disregard the value of humus and to rely almost wholly upon fertilisers.

The foregoing subject has been very adequately treated by D. P. Hopkins.²²

A valuable contribution dealing with the enormous populations of minute living organisms which soils contain, through whose operations a profound effect upon the fertility of plants is exercised, was made by Dr. J. H. Quastrel,²³ Director of the Agricultural Research Council, Unit of Soil Metabolism, in an interesting paper on "Soil Metabolism." In this paper Dr. Quastrel has suggested that soil should be considered from at least two viewpoints, (1) primarily as a medium for the growth of crops, all processes occurring within it being judged essentially from their importance in influencing crop production, and (2) as a complex biological system in which hosts of organisms are competing with each other, often for a limited supply of nutritional materials. These organisms exercise profound effects on each other's development and chemical activities, and establish between themselves a dynamic equilibrium which is for ever changing with every change in the physical and chemical environment of the soil. In such equilibrium the plant plays an important part. The root cells form part of the complex cell system of the soil and the development of the plant becomes a function of the equilibrium conditions set up in the soil.

Soil Microbiology

The chemical aspect of soil microbiology has assumed increasing importance as the factors contributing to crop production have been disclosed. There is no aspect of soil microbiology without its bearing on the chemistry of the soil. In the transformation that nitrogen undergoes in the soil, in the changes that affect sulphur, phosphorus, iron or manganese; in the breakdown of organic matter so essential for the development of the tilth or structure of the soil, the various transformations that convert a chaos of complex materials in the soil into something rather less complicated; the production of carbon dioxide—all these are the direct results of biological processes in the soil.

Soil has extensive microbiological populations, made up of a great number of species of bacteria and a genera of fungi, actinomycetes, and algae, as well as of numerous families of protozoa, nematodes and other invertebrates. Some conception of the enormous population of micro-organisms in soil is provided by the fact that there may be as many as 5,000,000,000 bacteria per

gram of soil, corresponding to a weight of over 4 tons of bacterial substance per acre of soil. The numbers of bacteria fluctuate very greatly, depending on the availability of food supply, moisture, aeration conditions, temperature, hydrogen ion concentration of the soil and other factors. It would be interesting to epitomise this most interesting contribution, but unfortunately space does not allow. The writer desires, however, to refer readers to the paper itself as representing a most valuable contribution to this significant subject.

In the second edition, just published, of "Calcium Superphosphate and Compound Fertilisers: Their Chemistry and Manufacture," the writer (with his colleague, Mr. Ogilvie), has urged the importance of silicophosphate as a suitable new fertiliser that will give results equal to basic slag, and indeed may be, in certain cases, used to replace calcium superphosphate. In this connection it is interesting to read one result of the East African Industrial Research Board.²⁴ The occurrence of rock phosphate in Uganda was known before the war, but it is only recently that the mines near Tororo have been exploited. This deposit resembles the Kola apatites of the U.S.S.R.

Soda Calcining Process

Following up-grading, it is found that the iron and alumina contents of the foregoing raw material are generally well above the limit regarded as satisfactory for treatment with sulphuric acid. Since soda ash from Lake Magadi is a local product, processes similar to that used for Rhenania phosphate in Germany have been tried, by which the basic form of phosphatic fertiliser is produced. The soda calcining process developed in the Board's laboratories differs from both the original German and the recent British methods of producing silicophosphate, in that silica is not a constituent of the furnacing mix, though the character of the East African material is stated to be very similar, from practical aspects, to silicophosphate.

The calcium superphosphate industry is being subsidised at the present time in respect of (a) sulphuric acid, and (b) phosphate rock, otherwise it would be impossible to continue business on a profitable basis. In certain quarters it was hoped that there would be a relaxation of control of fertilisers this year. The Board of Trade, however, through S. R. & O., 1946, No. 975, "Supplies and Services (Transitional Powers)" has produced a much more comprehensive Order, revoking and enacting in consolidated form, with amendments, the Control of Fertilisers Orders Nos. 27, 29 and 30, and prescribing maximum prices for such fertilisers as sulphate of ammonia, basic slag, compound fertilisers (N.P.K.

type), raw unground phosphate, ordinary calcium phosphate, muriate and sulphate of potash.

Adjustments are made in maximum prices for phosphatic fertilisers, the effect being to reduce the level of maximum prices for compound fertilisers and to raise that for superphosphates. Provision is made to cover increased delivery costs. Maximum prices are prescribed for "National Compound" fertilisers and compounds containing ammonium phosphate. The price of sulphate of ammonia has been advanced by the insignificant amount of 1s. per ton; the price of calcium superphosphate has advanced from £5 8s. 9d. per ton in 1945 to £5 16s. per ton for 18 per cent P_2O_5 in 1946.

The foregoing Order does not appear to confer any advantage on the product sulphate of ammonia industry, although it is likely to render it possible for synthetic ammonia works to operate at a reasonably uniform rate of production throughout the year. The problem of storage was an acute one in their case, and now that the practice is being repeated by which farmers and agricultural merchants are granted an early booking rebate, taking the export market into consideration, it would seem that there is something approaching a regular demand for sulphate of ammonia. Unfortunately, the ammoniacal products of gas undertakings are produced in seasonal quantities, and thus the new Order is less advantageous in their case.

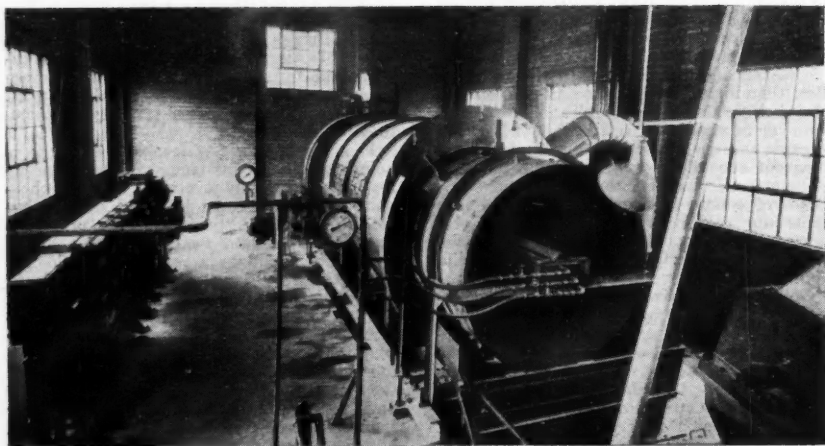
Three methods of manufacturing calcium superphosphate continuously, namely, the Broadfield, Nordengren and Mortiz-Standaert-Sturtevant, are being adopted to-day

1. Phosphate Feed Hopper; 2. Phosphate Feeder;
3. Mixer; 4. Den Platform or Roof; 5. Den Bowl;
6. Den Worm Drive; 7. Excavator; 8. Excavator Driving Gear; 9. Den Concrete Foundations; 10. Conveyor to Store; 11. Acid Storage Tank; 12. Acid Feeder; 13. Phosphate Feeder; 14. Fume Duct; 15. Retaining Panel for Wet Slurry; 16. Centre Mandrel; 17. Discharge Chute for Excavated Material.

Fig. 9 references. See Opposite Page.

in this country, and throughout the world. The last-named method has gained immense popularity during the last four years. Fig. 9 shows that it comprises a volumetric phosphate feeder (1 and 2), acid feeder (11 and 12), double-paddle mixer (3), and den (5). The ground phosphate rock is introduced to the feeder by a double-worm conveyor (13). When the feed hopper (1) is full, the surplus is returned by the bottom worm to the store and recirculated. A rotating hollow drum (2) measures the correct predetermined amount of phosphate and discharges it at each revolution into the mixer. The acid measurer is synchronised with the phosphate feeder and discharges at the same time into the mixer (3). This consists of a cast-iron trough, in which two shafts revolve, carrying double-arm paddles and stirrers, which afford thorough incorporation. The wet magma travels along the mixer and discharges directly into the den, immediately behind a vertical sealing panel (15). The den comprises a steel casing, lined with about 6 in. of concrete, and is rotated by a positive worm-ring and worm-drive at the base (6). A central cast-iron mandrel and cone (16) complete the internal construction.

Fig. 10. The Container of a Granulating Plant.



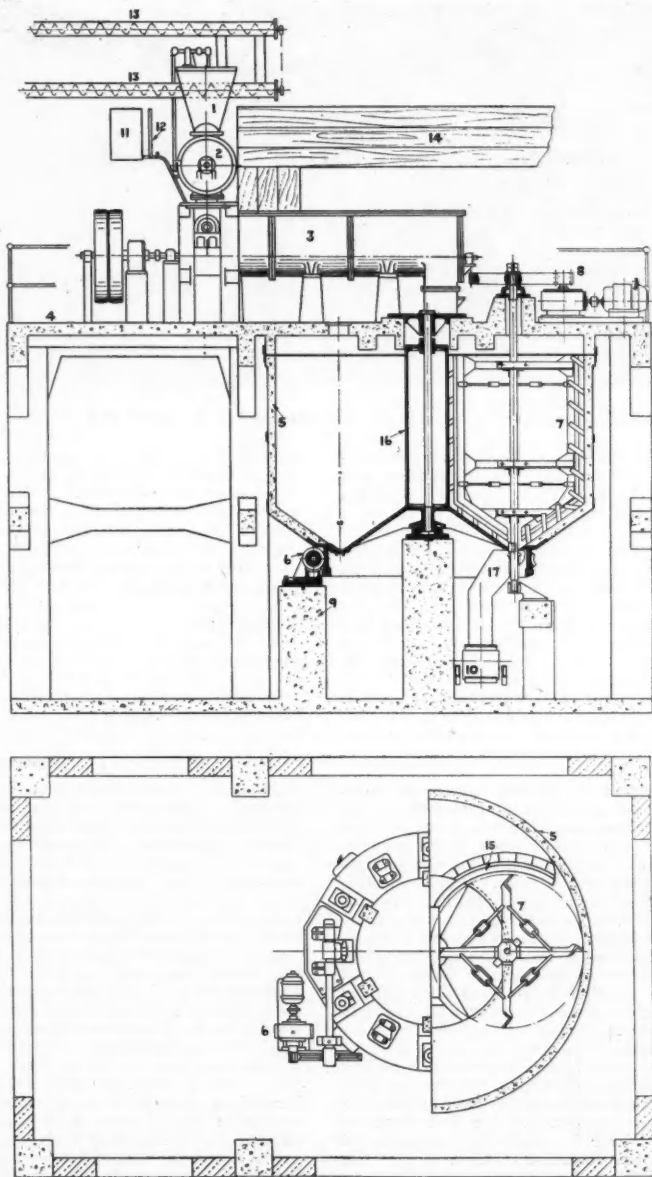


Fig. 9. The Moritz-Standaert Superphosphate Den.

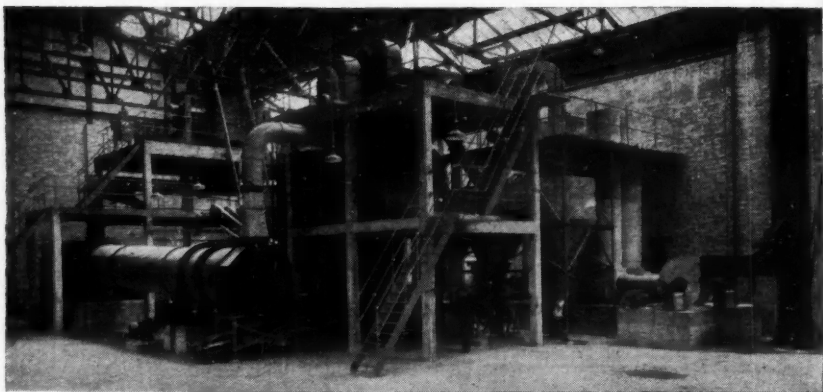


Fig. 11. The Modern Sturtevant Granulating Plant for N.P.K. Fertilisers.

The superphosphate builds up to a vertical wall between the central mandrel and the concrete lining, as the bowl revolves. The den bowl makes one revolution in about three hours, by which time the magma is hardened, and is ready to be cut out by the excavator (7). This is a steel framework, mounted on a vertical shaft and driven through gearing from a motor (8). On this framework are a series of knives, which are set at the required spacing to give a continuous cut of about half an inch on the surface of the superphosphate wall. These are adjustable, as wear occurs. The material, when cut, gravitates to the bottom of the den and discharges to a conveyor (10), via a shoot (17), from which it passes to the store.

The products of decomposition are withdrawn by a fan through a wooden duct (14), to pass through scrubber towers before discharge to the atmosphere. The complete unit works continuously, and needs the attention of only one man. The electric motors are all inter-locked, so that a failure of one of the units can arrest the operation of the whole plant, until the defect is rectified. Thus, costly breakages are avoided. The complete unit can be provided in capacities ranging from 5 to 25 tons per hour, which should cover all normal requirements.

The granulation of calcium superphosphate and N.P.K. fertilisers is proceeding apace. In the Sturtevant process the conditioner plays an important rôle in the production of the correct size and form of granule. Water is atomised at a series of points in the conditioner (Fig. 10). The particle size of the granules is a function of the quantity of water added. Any tendency to form fines in the final product can be counteracted by increasing the rate of

feed of water: conversely, any undue quantity of oversize can be avoided by reducing the rate of feed of water. A powerful light permits the operator to see what is occurring in the granulator, and he regulates the quantity of water atomised by visual observation of the particle size of the material passing through the conditioner. Fig. 11 is interesting, as showing one of the most modern granulating units.

Triple superphosphate appears to be a fertiliser product of the future, and efforts are now being made to devise a really effective continuously-operating unit of plant of a foolproof kind for the manufacture of this product.

Titanium and Zirconium

Along the east coast of Australia are dark red-brown sands rich in titanium and zirconium minerals. Three-quarters of the world production of zirconium silicate, rutile and ilmenite now comes from these deposits.²⁵ Some of the properties and uses of zirconium were mentioned in last year's review, but its field of application is constantly being extended and it is now largely employed in sparking plugs and insulators, for insulating high temperature electric elements, as well as in the rubber and steel industries. In the vitreous enamel industry the value of zirconium as an opacifier has been well established, and it is no longer necessary to use tin oxide, nor indeed any other form of opacifier as a mill addition. Zirconium enamels improve in opacity with successive firing, and their gloss and reflectance are of a very high order.

Ilmenite is used extensively in the production of titanium oxide, and in the steel industry.

Rutile and other titanium compounds have been used as substitutes for mica with

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such success that it is doubtful whether mica will again be used to its former extent.²⁶ The dielectric constant of commercially pure titania, and as a fired ceramic body in which all the titania is present as rutile, is 100 to 110 for frequencies from the power range through the very high radio frequencies, and this high constant persists into the infra-red range. Other forms of titania ceramics used for electrical purposes include those which contain titania other than as rutile, such as the titanates of the alkaline earths and those in which at least a small proportion of the titania is present in a reduced state. These substances are being

used to a rapidly increasing extent in radio, television and communications, and certain properties of some of the titanates show promise of usefulness in other diversified fields. As an example, it has been known for some time that titanium dioxide exhibits photosensitive characteristics, i.e., the surface resistance drops precipitously when illuminated with visible light. Evidence exists that if the titania bodies are made thin enough, so as to be translucent, the effect is greatly enhanced, and response appears to be instantaneous. Thus, possible economic substitutes for photo-electric cells, relays, etc., are indicated.

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RECENT PROGRESS IN THE NITROGEN INDUSTRIES

by E. B. MAXTED, D.Sc.

IT seems apposite, in connection with the present review, to preface this summary of recent papers and patents with a few remarks on the essential difference between the present state of the nitrogen industry and that which existed when the first of these nitrogen reviews appeared in *THE CHEMICAL AGE* just after the first world war. Then, as now, the state of the industry was reviewed immediately after a period of abnormal increase in the output of nitrogen products, particularly of nitric acid and of other nitrogen-containing chemicals used for the manufacture of explosives; but whereas the earlier period included the development of fundamental research on nitrogen fixation—above all relating to the synthesis of ammonia—as well as on the catalytic oxidation of ammonia to nitric acid and on conditions for the production of highly concentrated nitric acid from oxides of nitrogen, the present state of the industry is one in which the technology of these processes has long since become more or less standardised. Consequently, in spite of the unprecedentedly large output of nitrogen products during the recent war, relatively few inherently new manufacturing methods have been described, at any rate

in the published literature, particularly since this literature does not yet include much of the very large body of research work which has been carried out under security conditions both in Allied and in enemy countries. It may however be noted that considerable information on war-time industry in Germany has become available in the form of BIOS and similar official reports published by H.M. Stationery Office.

Of the papers which describe war-time synthetic plants, reference may be made to that by A. M. Miller and J. N. Junkins (*Chem. and Met. Eng.*, 1943, 50, Nov., 119), which deals with the plant at Muscle Shoals operated under the Tennessee Valley Authority. The general operation of this installation, which was based on the old Muscle Shoals factory of the first world war, is described at considerable length, with special emphasis on the engineering side; and a flow sheet is given later (p. 152). The starting point for the synthesis gas is a semi-water gas, which is first scrubbed with water and then purified of hydrogen sulphide by the Seaboard process. The next step consists in the catalytic conversion of the bulk of the carbon monoxide to dioxide by interaction with steam, the reac-

tion being carried out in two stages at, respectively, a higher and a lower temperature. In this way, more than 90 per cent of the monoxide is removed, with production of the corresponding amount of additional hydrogen. The carbon dioxide, which amounts to approximately 28 per cent of the gas, is absorbed by scrubbing with water at about 17 atm. pressure, the raising of the gas to this pressure constituting the first compression stage. About 50 per cent of the power required for pumping the water is recovered by means of a Pelton wheel. Carbon monoxide is then removed, in a further compression stage, by scrubbing with cold ammoniacal cuprous formate solution. The actual synthesis of ammonia is carried out at 350 atm.

Natural Gas Process

J. A. Lee (*Chem. and Met. Eng.*, 1945, 52, No. 12, 94) has described the utilisation of natural gas for the production of hydrogen for synthetic ammonia. This source is of great interest, especially in the United States and other oil-producing countries, since the provision of the hydrogen represents the major cost factor in ammonia manufacture. The natural gas, after being freed from sulphur compounds, is cracked in the presence of steam, with the production of hydrogen, carbon monoxide and carbon dioxide. The nitrogen required for the synthesis gas is then added, as air, by the regulated partial combustion of the above gas, some of the residual methane being eliminated, in addition of course to a part of the carbon monoxide and, unavoidably, some also of the hydrogen. From this point the process follows the normal course, i.e., the remaining carbon monoxide is converted as far as possible into the dioxide and hydrogen by catalytic interaction with steam. The method used for the subsequent removal of carbon dioxide—by absorption with β -amino-ethanol, $\text{CH}_3(\text{NH}_2)\cdot\text{CH}_2\text{OH}$, at 13 atm.—should be noted. After removing the residual carbon monoxide at 140-150 atm., the gas is compressed to 260 atm. for the synthesis of the ammonia, which is removed by liquefaction.

A further process involving the production of a hydrogen-nitrogen mixture by hydrocarbon-cracking has been described by J. H. Shapleigh (U.S. Pat. 2,166,611); and details of the use of the low-temperature fractionation method of preparing a synthesis gas from coke-oven gas have been given by J. W. Napier in the course of a paper read at a joint meeting of the Chemical Engineering Group of the Society of Chemical Industry and the Institution of Chemical Engineers during 1945.

Finally, although the ordinary form of the two-stage steam-iron hydrogen process is not, in general, employed for the synthesis of ammonia, attention may be drawn to the possi-

bility of producing hydrogen at what is already a high pressure by the reaction of a metal with water at pressure sufficiently high to maintain the water in a liquid state at the high temperature required for the reaction. W. H. Marshall (U.S. Pat. 2,182,747) has suggested the employment, in a process of this nature, of an iron-copper alloy (or even iron alone), the decomposition of the water being carried out at 230-370° at a pressure of 1000 to 10,000 lb. per sq. in. (70 to 700 atm.).

Catalysts for the synthesis of ammonia have now become more or less standardised; but special conditions for the preparation of catalysts containing iron, potash, magnesia and silica have been claimed by G. W. Abbot (U.S. Pat. 2,276,679). In this preparation, finely divided iron is mixed with specified small quantities of magnesium and potassium salts and silica, and pelleted with an organic binder. The pellets are heated in an atmosphere of steam before use.

A considerable amount of additional work on the mechanism of the synthesis of ammonia has been carried out by Russian chemists during the war. Thus, P. V. Usatschev (*J. Phys. Chem. Russ.*, 1940, 14, 1246) has published results which deal with the relative importance of adsorbed nitrogen and hydrogen. For instance, if nitrogen alone is first admitted to an iron-alumina ammonia-synthesis catalyst, no ammonia is formed immediately after the subsequent admission of a hydrogen-nitrogen mixture, whereas synthesis takes place without delay if the catalyst has been previously exposed to hydrogen. Work of this type has also been carried out by K. T. Koshenova and M. T. Kagan (*J. Phys. Chem. Russ.*, 1940, 14, 1250), who first passed a nitrogen-hydrogen mixture and observed the immediate cessation of the synthesis as soon as nitrogen alone was passed. On the other hand, the synthesis continued for several minutes if the nitrogen-hydrogen mixture was followed by the passage of a mixture of hydrogen and steam. The effect of small quantities of alumina and potash in not only raising the activity of iron for the synthesis of ammonia but also in inhibiting the course of the reduction of iron oxide by ammonia-synthesis gas has been studied by S. S. Latschinov (*ibid.*, p. 1260), the reducibility of the catalyst being correlated with its subsequent activity. This paper also contains other data relating to the influence of the reducibility and of the degree of reduction.

Other Aspects

In addition to the above reference relating to the synthesis of ammonia, several papers and patents dealing with ammonia generally may be noted. The storage and safe handling of liquid anhydrous ammonia

has been discussed by L. H. Brandt (*Chem. Industries*, 1943, 53, 200) with special reference to American tank-wagon practice. Another aspect of liquid ammonia is its use as a solvent in electrolytic cells. C. F. Silsby (U.S. Pat. 2,245,831) deals with improvements in the electrolysis of sodium and potassium halides in this solvent, the migration of the alkali metal out of the cathode section being suppressed by the interposition of fresh electrolyte between the anode and the cathode. An unusual war-time use of liquid ammonia has been described by E. Kroch (*J. Inst. Petroleum*, 1945, 31, 213), who gives details of the employment of this as a fuel in motor vehicles in Belgium during periods of diesel-oil shortage. It is stated that ammonia possesses good anti-knock properties and that its use as a fuel presented no difficulties.

Certain improvements in catalysts for the oxidation of ammonia to nitric acid have been proposed. Thus, F. E. Carter, S. L. Handforth, and W. E. Kirst (U.S. Pat. 2,167,708) have suggested the addition of up to 20 per cent of copper or silver to platinum or platinum-rhodium catalysts; and gauzes consisting of platinum containing about 10 per cent each of palladium and of rhodium have been claimed by A. R. Powell (Brit. Pat. 570,071). The recovery of platinum metal lost from the gauze or other form of the catalyst during its use for the oxidation has also received further attention. In general, the proposals (Baker & Co., and Hercules Powder Co., Brit. Pat. 542,330; G. M. Chastain, U.S. Pat. 2,226,113; F. Zimmermann, U.S. Pat. 2,226,149) involve some form of metallic filter, which is preferably inserted at a stage in the plant before that at which the temperature is low enough for the condensation of nitrogen oxides or nitric acid; but M. R. Chaikin and A. F. Volkov (*J. Appl. Chem. Russ.*, 1941, 14, 766) state that part of the platinum lost by the gauze can be recovered even by settling. The starting-up of these oxidation plants and particularly the avoidance of losses of product during the preliminary starting period have been dealt with R. S. Richardson (U.S. Pat. 2,185,607), who recommends that the platinum gauze should be heated to reaction temperature by combustion gases before the passage of the ammonia is begun; and N. A. Laury and A. P. Beardsley (U.S. Pat. 2,192,816) suggest an extension of this, or a similar, preheating treatment to the whole plant.

Older Practices

These improvements are alternatives to the usual practice of starting the reaction by initially heating the gauze, for instance, by an inserted flame, during the passage of the ammonia-air mixture used for the normal oxidation process. Other aspects of the reaction have also been con-

sidered. J. K. Dixon (U.S. Pat. 2,176,229) has suggested the insertion of gauzes of inert material before the platinum gauze in order to eliminate turbulence and irregular flow; and the control of the compressed air used in the oxidation has been discussed by D. G. Morrow (*Trans. Amer. Inst. Chem. Eng.*, 1942, 38, 377).

The general kinetics of the oxidation of the primary product, nitric oxide, to nitrogen peroxide have been discussed by F. Perktold (*Z. angew. Chem.*, 1942, 54, 461; *Chemie*, 1942, 55, 243); and the question of the optimum oxygen concentration, leading to a minimum time for the oxidation, has been examined by A. M. Murzin (*J. Appl. Chem. Russ.*, 1944, 17, 307). M. J. Kalous (Brit. Pats. 569,687 and 565,728) claims various improvements in the absorption of nitrogen oxides under pressure in stages using nitric acid of differing concentrations, with appropriate variations in the absorption temperature. In this connection, the somewhat earlier patents of I. Hechenbleikner (U.S. Pat. 2,138,165) and of R. S. Richardson (U.S. Pat. 2,135,733) may also be noted.

Oxygen-Steam Mixture

Finally, A. H. Manning (*see Brit. Chem. Abstracts*, B.I., 1943, 242) has described the operation of a plant of the type in which the ammonia is oxidised by an oxygen-steam mixture in place of ordinary air. Since the steam can be removed by condensation immediately after the gas has left the catalyst (before the oxidation of the relatively insoluble nitric oxide to soluble nitrogen peroxide has occurred to any great extent) and since very little diluent nitrogen is present, liquid nitrogen peroxide can be obtained directly for use in the manufacture of concentrated nitric acid by the enrichment process. Further details are contained in a patent of Bamag, Ltd., and A. H. Manning (Brit. Pat. 547,959).

Nitric acid produced by the oxidation of ammonia has already been treated in the preceding section. Its concentration by the sulphuric acid method forms the subject of several further patents. R. F. Peterson and P. G. Wrightman (U.S. Pat. 2,201,621) have claimed a process in which hot acid vapours for the production of concentrated nitric acid from a mixture of sulphuric acid and dilute nitric acid flowing downwards through a concentrating tower are provided by allowing the liquid from the bottom of the tower to flow through a number of strongly heated film-evaporators. In a further patent (F. Carl, U.S. Pat. 2,139,721), hot sulphur trioxide is passed upwards through the tower under special conditions.

The manufacture of nitrates by the action of nitric acid on alkali or alkaline earth chlorides is represented by a series of patents (H. A. Beekhuis, U.S. Pats.

2,185,579, 2,185,580, 2,261,329, 2,268,999, 2,296,762 and earlier patents). In general, in addition to the alkali nitrate, a gaseous mixture of nitrosyl chloride and chlorine is obtained. This mixture is separated by fractionation; and the nitrosyl chloride is oxidised to nitrogen peroxide and chlorine, the former of which can be used for the manufacture of more concentrated nitric acid for the treatment of further alkali chloride.

Ammonium Salts

Conditions for the preparation of ammonium nitrate have been further studied. D. A. Rogers and C. W. Brown (U.S. Pat. 2,167,464) have proposed the use of the heat of neutralisation of nitric acid with ammonia for the evaporation of the solution. R. W. Cairns (U.S. Pat. 2,166,579) has described the production of dense free-flowing crystals of ammonium nitrate by the cooling of hot solutions of the salt to the transition point; and J. R. Adams and C. W. Whittaker (*Ind. Eng. Chem.*, 1944, 36, 1088) have studied the preparation of ammonium nitrate for agricultural use, with special reference to the avoidance of caking.

A method for the reduction of potassium or sodium nitrate to nitrite by reduction with hydrogen in a tower in countercurrent to the molten nitrate, has been claimed by J. R. Bates (U.S. Pat. 2,294,374); and further methods for rendering alkali nitrites non-caking have also been described (L. A. Hall, U.S. Pat. 2,145,417; F. S. Chambers, U.S. Pat. 2,316,154 and 2,327,767).

Ammonium nitrate has already been dealt with. In addition, several patents covering modifications in the manufacture of ammonium sulphate and of ammonium halides may be noted. G. A. Phillipson and R. Thomas & Co. (Brit. Pat. 557,924) have suggested the addition of sulphuric acid in an atomised state to a stream of gaseous ammonia, the resulting mixture being bubbled through dilute sulphuric acid. Large crystals of the sulphate are deposited, which can be freed from free acid by being washed with a little water in a centrifuge. The control of the nature and size of the crystals obtained during the evaporation of a sulphate solution by adding small quantities of ferric, aluminium and magnesium salts has been described by R. G. Franklin, R. M. Roberts, and Imperial Chemical Industries, Ltd. (Brit. Pat. 549,641); and modifications in the recovery of ammonia from coke-oven gas by sulphuric acid scrubbing are treated in a specification of the Somet-Solvay Engineering Corporation (Brit. Pat. 559,360). In earlier reports, many modifications in the preparation of ammonium sulphate by the interaction of calcium sulphate and ammonium carbonate have been reviewed. A further treatment of this type of process is contained in a paper by G. Claude (*Compt.*

rend., 1941, 213, 105) in which the direct use, as a fertiliser, of the calcium carbonate precipitated in the first stage of the process is suggested, since it contains not only lime but also considerable amounts of ammonium sulphate. Proposals are also made for the saving of some of the evaporation costs in later stages of the process by adding ammonia to the warm solution of ammonium sulphate in such a way that crystals of the sulphate are caused to crystallise out.

Special methods for the manufacture of ammonium chloride and sodium sulphate, which are afterwards separated, by virtue of their differing solubilities, by crystallising out at different temperatures are dealt with by E. J. R. Cook (*Canadian Chem.* 1945, 29, 221). The primary process involves the treatment of a sodium chloride solution with sulphur dioxide and ammonia; and the paper includes a description of suitable plant. W. Hirschkind (U.S. Pat. 2,132,513) specifies some improved conditions for making ammonium chloride from gaseous ammonia, gaseous hydrochloric acid and water, followed by cooling to precipitate the chloride. The formation of ammonium chloride from separately heated streams of ammonia and hydrochloric acid gas passed into an unheated reaction chamber has also been dealt with by A. H. Maude (U.S. Pat. 2,308,293); and the manufacture of acid ammonium fluoride from gaseous ammonia and hydrofluoric acid have been studied by A. R. Bozarth (U.S. Pat. 2,270,498).

Hydrocyanic Acid

T. N. Montgomery (Brit. Pat. 562,917 and 564,094) has dealt with the production of hydrocyanic acid by the passage of nitric oxide and gaseous hydrocarbons over a platinum catalyst; or, in place of pre-formed nitric oxide, the reaction may be carried out with ammonia and a regulated quantity of oxygen. Other methods of making hydrogen cyanide are represented by the non-catalytic reaction of nitric oxide and a hydrocarbon in the presence of steam or a diluent gas at a high temperature (C. R. Harris, U.S. Pat. 2,184,062) and by a process involving the injection of ammonia and carbon monoxide, together with powdered lime containing thoria (R. T. Schraubstadter, U.S. Pat. 2,246,014) into a chamber at 450°. Further methods of preparation include the dehydration of formamide with acetic anhydride (H. Dreyfus, R. W. Moncrief, and H. O. Williams, Brit. Pat. 574,532) and with an alkyl phosphate catalyst at about 550° (L. Fallows and E. V. Mellers, Brit. Pat. 574,473).

Several papers and patents dealing with the manufacture of cyanates and thiocyanates have been published. H. R. Newmark and J. H. Pearson (U.S. Pat. 2,334,723) give conditions for the oxidation of alkali

cyanides to cyanates by air at a high temperature; and Koray, Ltd., C. D. Moore, and J. Grayson (Brit. Pat. 567,216) have described the conversion of potassium thiocyanate into cyanate by heating with zinc oxide.

The preparation of ammonium thiocyanate from ammonium thiocarbamate is treated by L. L. Lento and D. W. Jayne (U.S. Pat. 2,249,962) and by R. A. Mathes (U.S. Pat. 2,179,943). In the former process, oleic acid or ammonium oleate is used as a catalyst for the formation of ammonium thiocarbamate, from ammonia and carbon disulphide, in aqueous alcoholic solution; and the conversion of this thiocarbamate to thiocyanate, with evolution of hydrogen sulphide, is then carried out by a distillation process by means of which the alcohol also is recovered.

In the latter process, the conversion of ammonium thiocarbamate to thiocyanate is effected by heating in a non-ionising organic solvent in which the thiocyanate is only very slightly soluble. A specification of W. H. Hill (U.S. Pat. 2,286,273) may also be noted. This refers to the use of anhydrous liquid ammonia under pressure for the manufacture of ammonium thiocyanate from carbon disulphide and ammonia. G. H. Foster and C. E. Funk (U.S. Pat. 2,293,031) claim a further method in which ammonium thiocyanate is made, from ammonium sulphide, ammonia, sulphur and hydrocyanic acid, by a continuous process for details of which the original specification should be consulted. Finally, reference may be made to a review of recent developments in the field of thiocyanates by J. H. Clayton (*Chem. and Ind.*, 1942, 420).

THE BRITISH CHEMICAL INDUSTRY A CENTURY AGO*

THE chemical industries occupied, relatively, a much less important position a hundred years ago than they do to-day. But they were already considerable; and their importance was increasing fast under the impetus given to them by the rising demand of other industries for materials which they supplied. For example, there was a very rapidly growing demand from the textile industries for bleaching and dyeing materials: the glass industry and tanning industry were other important consumers of chemical products; and, within the range of finishing industries which can be described as largely chemical, there was a rapidly advancing demand for soap and for paint, as well as for matches and many other products largely of chemical origin.

The most important branches of the chemical industry proper were those engaged in the production of sulphuric acid and of alum, which itself required sulphuric acid as an ingredient. The manufacture of soda was also based on sulphuric acid; and soda was one of the main ingredients of soap. The other principal raw material of soda was common salt; and the mining and manufacture of this salt therefore also found its place among the branches of the chemical industries.

Of the natural materials used in these industries, sulphur was mainly imported, Sicily being the principal source of supply, though some sulphur was produced at home from iron pyrites or copper pyrites, as a by-product of the smelting of iron and copper. This, however, paid only when the price of imported sulphur was abnormally high; and

usually the manufacturers preferred to import the material from the Sicilian mines, which were partly controlled by British companies.

Salt, which was used in conjunction with sulphuric acid in making soda, was produced mainly from the Cheshire salt mines; but some came from mineral springs, as at

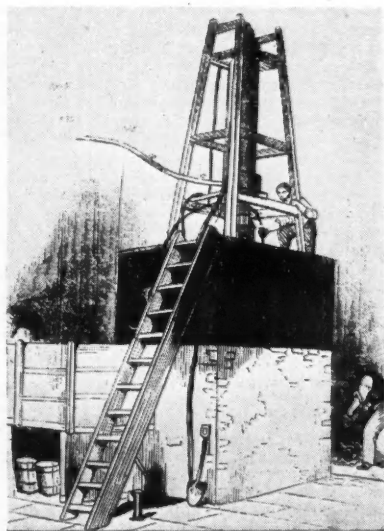


Fig. 1. A platinum "still," for concentrating sulphuric acid.

* From Common Ground's "British Industry 100 years ago—Chemicals and Public Services". Illustrations from photographs kindly supplied by Common Ground Ltd.

Droitwich, and some, especially in Scotland, was made by evaporation from sea water.

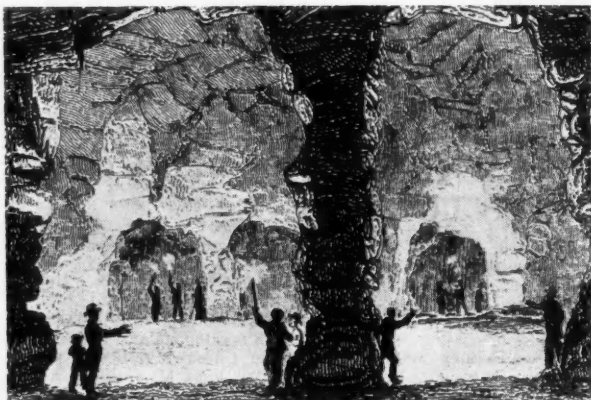
Potash, an important ingredient in the making of soap, was mostly imported from America—especially from Canada—where it was produced from the ashes of trees of virgin forests which were being cleared for agricultural use.

The main centres of the chemical manufacturing industries a century ago were around Glasgow, Newcastle-on-Tyne, and Liverpool. They were usually carried on

Lavoisier, Dalton, Davy, Faraday, etc.—are not at this stage connected in any direct way with the chemical industries.

The manufacture of medicinal drugs advanced step by step with the advance of basic chemistry. The large-scale production of medicines was only in its infancy, though there were already "patent medicines" advertised under fancy names, and, of course, the pharmacists obtained their ingredients from the chemical manufacturers.

Sulphur for the sulphuric acid process

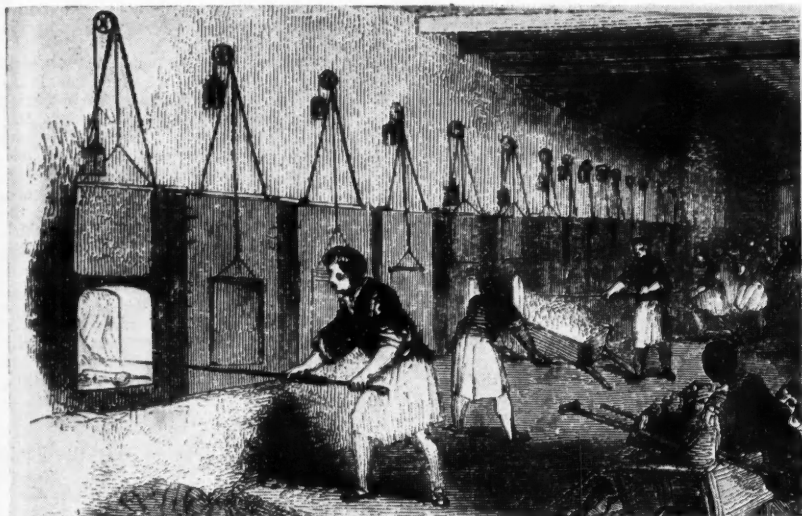


Salt for soda manufacture was produced mainly from the salt mines of Cheshire, one of which is shown here.

well outside towns, as they needed large amounts of ground and were, besides, both smelly and in many cases unhealthy, much difficulty being experienced in getting rid of waste gases evolved during the processes of manufacture and in disposing of waste products. Soap manufacture was also carried on in these areas on a large scale, and also in London, Hull and Bristol.

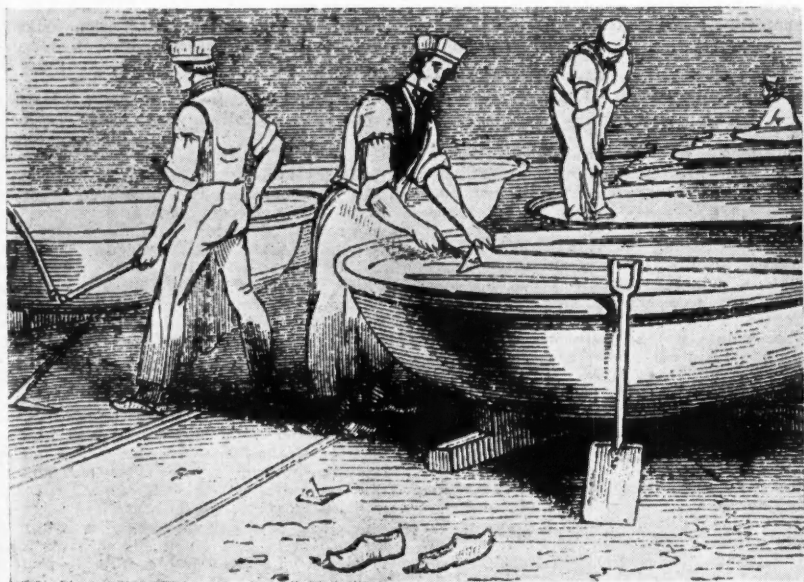
Scientific chemistry was making great advances and in consequence the processes of chemical manufacture were undergoing many important changes. In many cases older and newer methods of production existed side by side. Already, however, it had become evident that the basic processes could be carried on effectively only by large firms with considerable capital; and companies owning a number of related undertakings had already emerged, particularly in the Clyde area and in Lancashire and Cheshire. In these big firms the chemical laboratory had already come to be regarded as a necessary part of the equipment; but it was used rather for testing than for any systematic research. The great chemical discoveries of the early nineteenth century and also their main applications were devised not in the laboratories of industrial establishments, but outside them by scientists not directly connected with industry. Most of the great names of chemistry—Priestley,

was mostly got by mining, the chief source a century ago being the great sulphur mines in Sicily, from which it was brought to Great Britain in masses weighing about half-a-ton each. An alternative source of sulphur was the roasting of iron or copper pyrites, which have a high sulphur content; but though many works were equipped for extracting the sulphur from pyrites, they used this process only when the price of imported sulphur was exceptionally high. Some "acid" was sold to the manufacturers in the state in which it left the "chamber" but for many purposes it needed to be further concentrated and this had to be done by heating it, but the difficulty here was that lead which would resist the corroding influence of the acid would not stand the heat required without melting. It was necessary to use some other material for the containers in which the acid was to be heated. Glass was often used for the purpose, but was very liable to break; and the more modern practice was to use platinum, which was very expensive and difficult to work. The platinum was made as thin as possible, and was built round with an iron casing; but even so the "stills" used were very costly. Fig. 1 shows the kind of platinum "still" used in concentrating the acid which was then packed in large glass vessels for sale to the consuming industries.



(Above) Fig. 3. A "balling furnace," in which sulphate of soda was treated before being raked out into iron pans and wheeled away on trucks for further treatment.

(Below) Fig. 4. The soda was later placed in a cool atmosphere in pans of the type shown here and allowed to crystallise out.



One of the principal uses of sulphuric acid was in making soda, which was employed for a very wide variety of industrial as well as for household uses. It was needed, especially for soap making and for the bleaching of textiles, and also in the manufacture of glass. The chief ingredients used in making soda were sulphuric acid and common salt. Salt, on the repeal of the salt duty in 1825, had replaced other materials which had previously been extensively used—especially "kelp" and "barilla," two kinds of seaweed. The "kelp" process had employed large numbers of persons in Scotland, especially in the Highlands; but these had been mostly thrown out of work by the substitution of common salt from the mines. The first process in treating the salt was to cook it in a leaden pan placed in a reverberatory furnace—that is, one in which the heat was driven down on the pan from a low roof without actual contact of the fuel with the salt, and to let in sulphuric acid through a lead pipe. The acid liquefied the salt, and in the process the furnace gave off a large quantity of muriatic (or hydrochloric) acid gas, which used to be discharged into the air by the chemical factories from the very tall chimneys in order to mitigate its noxious effects. The more up-to-date factories, however, were already using a better method of disposal, by pouring the gas into towers filled with coke and kept wet with streams of water trickling through the coke. This converted the gas into an acid, which could then be sold to manufacturers for a variety of uses.

Treatment of the Soda

The removal of the hydrochloric acid left sulphate of soda, which needed further treatment. It was mixed with chalk or lime and coal and placed in a "balling furnace." While in the furnace it was stirred with a rake, and when heated sufficiently was removed by the rake on to an iron pan and wheeled away on trucks for further treatment (Fig. 3).

The "ball-soda," as it left the furnace, consisted mainly of two substances—carbonate of soda and sulphate of calcium, and it was next necessary to remove the second of these. This was done by putting the ball-soda into a tank with water, so that the soda dissolved and the solution could be drawn off at the bottom. The liquor thus procured was transferred to an evaporating furnace, and heat was applied to the surface. This removed the water, leaving the soda in the comparatively impure form of "soda-ash" or "soda-salt" in which form it was extensively sold to manufacturers. For other uses, however, the soda had to be crystallised. This involved dissolving it again in water, allowing it to settle, and then boiling it. After this it was placed in a cool atmosphere in large pans of the kind seen in Fig. 4,

and was allowed to crystallise. The crystals were then broken away and packed in barrels for the market.

Alum, ordinarily a compound of sulphuric acid, clay and potash, is sometimes found and mined in a natural state: alum-mining was carried on in Yorkshire, near Witby, and, more extensively, in Scotland, where there were big mines near Glasgow and Paisley. In the Hurler mines, near Paisley, mining for alum was carried on in connection with coal and limestone mining, the alum being got largely from pits from which the coal had already been removed. The alum-bearing strata, having been exposed to air by the removal of the coal, had crumbled, so was easily worked. The material was taken from the mines and placed in large "steeps," in which it was covered with water impregnated with sulphate of iron and alumina. The saline matter then passed into the water.

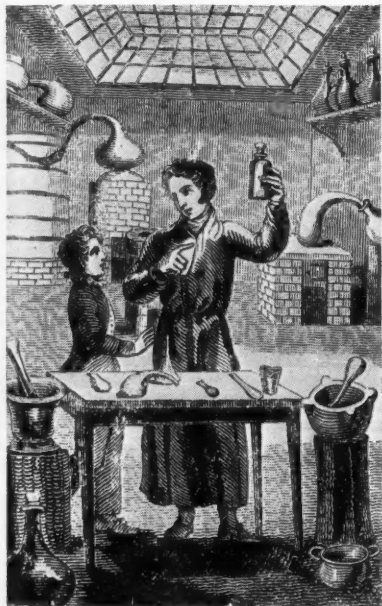
Prolonged Processes

The next process was to heat the liquid thus produced in order to evaporate most of the water, leaving a concentrated solution, which was then poured off and left to cool. Fig. 6 shows the boilers in which this process of evaporation was carried out. The subsequent cooling process occupied as much as a fortnight. Sticks called "riders," were placed in the coolers, and on these the sulphate of iron which was still contained in the solution crystallised, forming the substance known as "copperas," which was removed and sold to dyers and colour-makers. There followed a further process of evaporation, in which potash was added, in order to crystallise the alum.

There were somewhat different processes from those described when alum was produced by synthetic means. The alum produced from Cornish clay or synthetically was often crystallised in tall tanks into large cylindrical masses. The tanks were made so as to take to pieces when the crystallisation was complete, leaving the alum in the form of a pillar made up of crystals.

Soap-makers a century ago used tallow which came chiefly from Russia. The soda was produced from common salt, which had largely replaced the "kelp" alkali, made from seaweed. The first process of soap-making was the production of "lye," by removing the acid from the rough carbonate of soda bought from the chemical works. This "lye" was then mixed with the tallow, and was boiled. The tallow absorbed the alkali from the lye, which was poured off by a pump. Fresh lye was then added, and the process was repeated a number of times until the soap was made.

The soap was then poured off into frames of wood or of cast-iron, made so as to take to pieces. The soap in the frames was left to cool; and then the frames were removed,

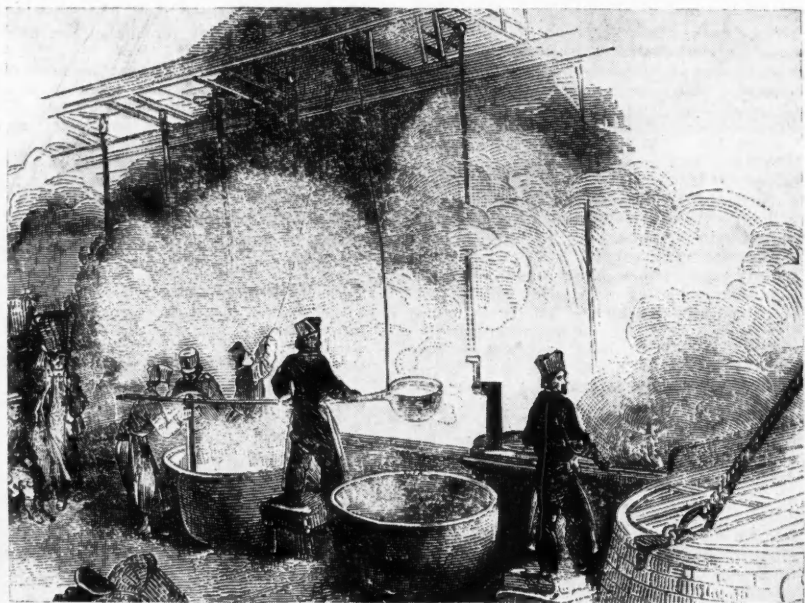


(Above) Fig. 5. A chemist of 1846.



(Above) Fig. 6. The primitive boiler in which was carried out the process of evaporating alum.

(Below) Fig. 7. Soap making.



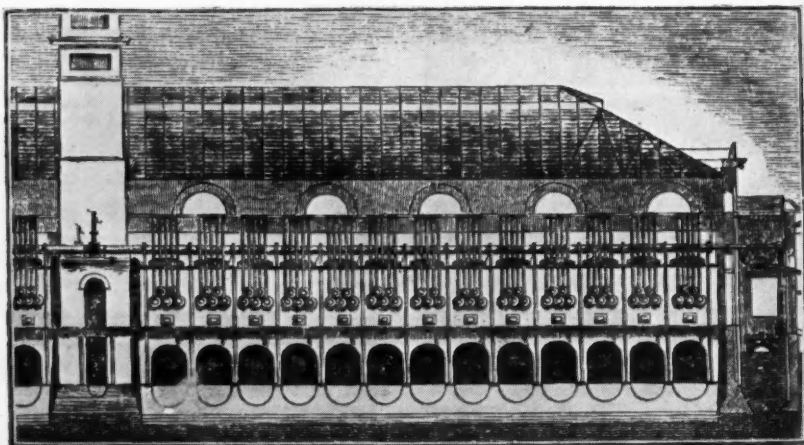


Fig. 11. An early retort-house of the kind used in gas-making. Each side of the retort-house had a series of arched recesses forming ovens or furnaces, about eight or ten feet high.

leaving the soap standing in a large lump. This was next cut with wires, by hand, first horizontally and then, in a special frame, vertically, so as to make it into the "bars" in which common soap was sold. Other soaps were made in different ways. Soft soap, for example, was made with potash instead of soda and often with oil instead of tallow, or with a mixture of oil and tallow. The potash was imported, mainly from Canada or the United States. "Fancy" toilet soaps were usually made by remelting ordinary "bar" soap and adding perfumes or special ingredients. The ordinary "bar" soaps were "white," "yellow" or "mottled." "Yellow" was the cheapest. "White" was made from specially selected tallow. "Mottled" was made by sprinkling a special "lye" near the final stage of boiling. But the essential processes were the same in all cases.

The making of candles was carried out, a century ago, either as a hand-process in small workshops or in factories with the aid of complicated machines. The more expensive candles were made of wax or spermaceti, and not of tallow; but the processes were much the same. Cheaper still were "rush-lights," which were largely used by the poor, the wick being made of rushes instead of cotton. "Rush-lights" were made simply by dipping the rushes in liquefied tallow, and were not shaped, as candles were.

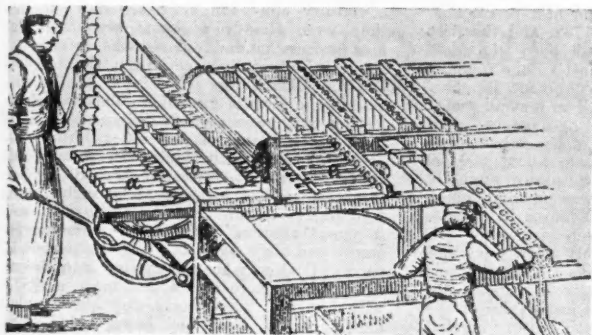
The chemist, in 1846 was the maker of medicinal drugs. Technically a "chemist" dispensed medicines, whereas a "druggist" sold them ready-made; but the callings were often combined. An "apothecary" belonged to a superior calling, for he prescribed as

well as dispensed. There were great differences in the extent to which chemists prepared their own chemical preparations, or bought them from the chemical manufacturers. In Fig. 5 a chemist is shown with pestles and mortars in the foreground, for preparing ingredients of drugs, and the copper "alembic," or "still," in the background, with retorts, etc., and the circular furnace on the left for boiling or melting substances.

A hundred years ago, what are now called "public utility" services were in a very rudimentary stage of development. The most advanced was the supply of water, which was already in some places (and had been for long past) in the hands of municipal bodies, but elsewhere was being developed by water companies. Water was still chiefly derived from rivers or from wells. Artesian wells were in common use; but especially in London the level of the underground water had sunk, so that the wells were no longer strictly "artesian," but had to be pumped up from some distance below the surface. London also derived a large part of its supply of water directly from the Thames. The famous engine for raising Thames water by tidal action was first installed in 1582; and this method, as shown in Fig. 10, remained in use until 1822, the wheels being installed beneath the arches of old London Bridge. In 1822 they were removed, when new London Bridge was built.

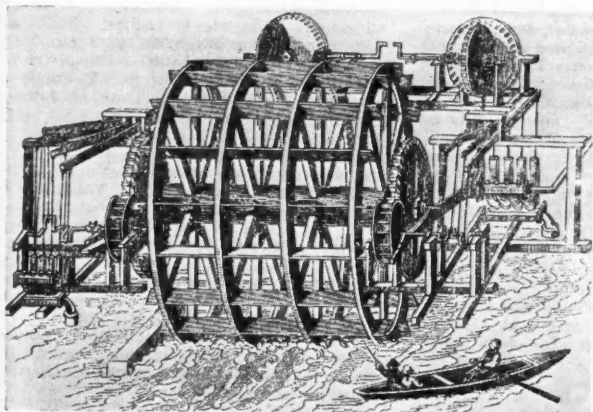
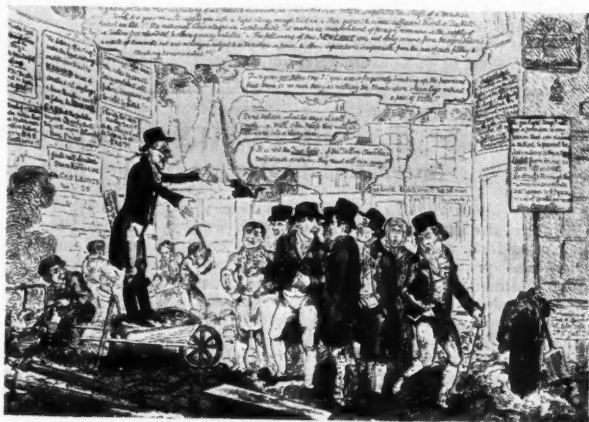
Coal-gas had begun to be used for illumination on a considerable scale, the first gas companies dating from early in the nineteenth century. Murdoch, the engineer who worked with James Watt on the development of the

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(Left) Fig. 8. The making of candles was carried out with the aid of complicated machinery, such as this.

(Right) Fig. 9. The laying of gas mains was at first much opposed. Here a contemporary artist depicts the controversy raging as workmen proceed to dig up the street.



(Left) Fig. 10. London drew a large part of its water supply a hundred years ago direct from the Thames. The water works illustrated were installed beneath the arches of the old London Bridge.

steam-engine, had made the first practicable gas-lighting apparatus in 1792, and the first large-scale application had been the gas-lighting of Boulton and Watt's Soho foundry a few years later. Murdoch made the first gas-holder, or "gasometer," on a small scale; and by the 1840's large "gasometers" had become a familiar feature of the urban landscape. By the late 'forties, about 600,000 tons of coal were being consumed annually in making gas. There was at first much opposition to laying of gas mains in streets.

Gas-making processes were somewhat primitive. Gas-coke fetched only a low price, not yet having been developed as a domestic fuel; and there was great difficulty in disposing of the tar, until the chemical discoveries of the second half of the nineteenth century created new outlets for it and for other by-products of gas manufacture. Gas producers required a coal which would yield both a good supply of gas and a marketable residue in the form of coke. Other by-products, such as ammonia and tar, were of less commercial importance

a century ago than they are now, though they were already of some account. The first process in making gas was to separate the carburetted hydrogen from the body of the coal, which was left behind by the process in the form of gas-coke. This was done, at the first stage, by distilling the coal in highly-heated vessels secluded from the access of air. Each side of the retort-house (Fig. 11) had a series of arched recesses forming ovens or furnaces about eight or ten feet high. A number of empty iron containers, "retorts," were placed in these ovens empty and made red hot by fires lighted under them. Coal was then shovelled into the retorts, which were closed and made air-tight with cement. The retorts were then cooked for five hours, fresh fuel being added every hour. The gases having been drawn away, the retorts were emptied, and the coke in them cooled with water. Much of the coke was used in the gasworks as fuel for the retort-house: the surplus was sold in the market mainly for use in other industries.

Chemistry Congress

International Meeting to be held in London

THE eleventh International Congress of Pure and Applied Chemistry, which was arranged to be held in 1941, in London, and then was postponed by the war, has now been planned to take place this year. It will be held in London from July 17-24 and will follow the centenary celebrations of the Chemical Society on July 15-17.

The preliminary announcement issued by the hon. organiser, Mr. Francis J. Griffin, 56 Victoria Street, London, S.W.1, indicates that the Congress will be divided into the following 13 sections: Inorganic and Geochemistry; Physical chemistry; Organic chemistry; Biochemistry; Chemistry in relation to agriculture and applied botany; Chemistry in relation to applied zoology and veterinary science; Chemistry in relation to food and nutrition; Chemistry in relation to medicine and therapeutics; Chemistry in relation to fuel, power and transport; Chemistry in relation to natural and artificial textiles; Chemistry in relation to plastics, glass and ceramics; Chemistry in relation to metals; Chemical engineering.

The provisional programme is as follows:

July 16, 6 p.m., Registration of members and delegates at Congress headquarters; 9.30 p.m., Informal reception of delegates and members.

July 17, 10.30 a.m., Opening ceremony by the president of the Congress at Central Hall, Westminster; 1 p.m., Luncheon; 2.30 p.m., Congress lectures; 9 p.m., Reception of delegates and members.

July 18, 9 a.m.-12.30 p.m., Meetings of

sections; 12.45 p.m., Luncheon by the Society of Chemical Industry; 2.30 p.m., Meeting of sections and Congress lecture; 9 p.m., Visit to theatre.

July 19, 9 a.m.-12.30 p.m., Meetings of sections; 2.30 p.m., Motor-coach tour of the City of London; 8 p.m., Congress dinner, buffet and dance.

July 20, A series of day excursions to places of interest near London.

July 21, 9 a.m.-12.30 p.m., Meetings of sections; 2.30-5.30 p.m., Congress lectures; 9 p.m., Reception by the Royal Society.

July 22, 9 a.m.-12.30 p.m., Meetings of sections; 12.45 p.m., Luncheon by Imperial Chemical Industries; Ladies' luncheon; 2.30 p.m., Motor-coach tours; 9 p.m., Reception by Royal Institute of Chemistry.

July 23, 9 a.m.-12.30 p.m., Meetings of sections; 2 p.m.-6 p.m., Tour of London museums and exhibitions; 7.30 p.m., Gala banquet.

July 24, 10.30 a.m., Closing session of the Congress; Lecture by the President of the Royal Society, Central Hall, Westminster.

North American Cyanamid, Ltd., has concluded an agreement with the Canadian Government to acquire the war-built Welland Chemical Works, in the townships of Thorold and Stamford. The plant produces ammonium nitrate fertiliser and other chemical products, and will continue under the management that has had charge of its operations for the Government.

ENZYME CRYSTALLISATION

by PROFESSOR J. B. SUMNER*

THE year 1926 is notable in the history of science because it witnessed the preparation in pure form of the first hormone, the first vitamin and the first enzyme. These were, respectively, insulin, crystallised by Abol; vitamin B₁, or thiamine, crystallised by Janson and Donath; and the enzyme urease, crystallised by Sumner.

Hormones, vitamins and enzymes occur in all living things. The hormones can be defined as chemical messengers; some are proteins, while others are steroids and one is an amino acid. Vitamins are always relatively simple substances and may be alcohols, amines, organic phosphates, etc.

Enzymes are the tools of the cell. They cause chemical reactions to go on. They bring about digestion, fermentation, respiration, fertilisation, growth and, in fact, nearly every chemical process involved in the phenomenon which we call life. The muscle cell is known to contain 60 different enzymes and probably contains many more which await discovery. Yeast cells doubtless contain a much greater assortment of enzymes than muscle cells, since yeast possesses a greater number of functions to perform.

The Oxidases

While all enzymes thus far isolated have been found to be proteins, one class of enzymes, the oxidases, which bring about cell oxidations and produce energy and heat, has been found to consist of compound proteins. Here a protein is attached to a coenzyme. The coenzyme has a relatively simple structure derived from and closely related to a vitamin. From this it has developed that the animal eats vitamins in order to produce coenzymes.

Pure enzymes form microscopic crystals which nearly always belong to either the isometric or to the hexagonal system. Most enzymes in the solid state are colourless, but some are yellow and others are brown. Catalase, isolated from beef liver by Sumner and Dounce in 1937, is brown. With a few exceptions all enzymes are destroyed by boiling. Enzymes that are out of place are dangerous to life. Thus, the venom of poisonous snakes, bees, wasps and scorpions is nothing more than a mixture of many enzymes and when introduced into the body these enzymes destroy tissues with which they come in contact.

The reason why the isolation of enzymes in pure form was so long delayed is because

enzymes occur in plants, animals and micro-organisms in minute amounts, because enzymes are usually very unstable and because enzymes are colloids, or glue-like substances, whose physical properties require a special type of treatment.

The isolation of urease by Sumner was the first instance of success after nearly 100 years of effort to obtain an enzyme in pure form and to find out what it was chemically. In Germany the noted chemist Richard Willstätter and his staff carried out an immense amount of work in attempts to isolate enzymes, but without success. The claim of Sumner of having isolated urease was bitterly contested by members of the Willstätter school, but finally admitted to be true some ten years later. During this interval Professor Sumner made two trips to Sweden for the purpose of obtaining additional evidence supporting his claim. In 1929 he worked in the laboratory of Professor Hans von Euler at Stockholm Högshule and in 1937 he carried on experiments at Upsala in the laboratory of Professor The Svedberg.

Researches in other laboratories furnished powerful support for the isolation of urease. Dr. John Northrop of the Rockefeller Institute was able to crystallise pepsin in 1930, and shortly afterward Northrop and Kunitz crystallised trypsin and chymotrypsin. In Sweden Professor Theorell crystallised the yellow enzyme of Warburg. Recently he has crystallised peroxidase. To date nearly thirty enzymes have been obtained in pure condition by various scientists and today nobody hesitates to accept the pioneer work of Sumner. The importance of enzymes has now been fully realised and many problems in biology are being solved through a study of individual enzymes and those chemical reactions which they either hasten or initiate. One definition of life is: "A proper and orderly functioning of enzymes."

LACTIC CASEIN PRICES

The Director of Sundry Materials, Board of Trade, 10, Old Jewry, London, E.C.2, announces that the selling prices of lactic casein, distributed through the agency of the Lactic Casein Importers' Association, Ltd., 23 St. Swithin's Lane, E.C.4, are:

	One ton and over	Under one ton
Mesh		
90	£240	£245
60	£235	£240
30	£235	£240
Soluble	£245	£250

* Professor of Biochemistry at Cornell University; awarded 1946 Nobel Prize for his work on the crystallisability of enzymes.

PROGRESS IN DRUGS & FINE CHEMICALS

by G. COLMAN GREEN, B.Sc., F.R.I.C., A.M.I.Chem.E.

IN the autumn of 1946 the centenary of inhalation anaesthesia was celebrated. The idea of producing a state of insensitivity to pain dates back to beyond 1846; but it was during this year that, out of the fashionable "animal magnetism" seances and the "ether frolics" which obscured and discredited genuine scientific progress, there came the greatest blessing conferred on suffering mankind. It was fundamentally from the "pneumatic chemistry" of Beddoes and the studies of gases and respiration by the immortal Lavoisier, Priestley and Humphrey Davy that the great advance of 1846 may be said to have flowed.

For the greater part of the century commencing with 1946 the original inhalation anaesthetics—ether, chloroform and nitrous oxide—were unchallenged. Nitrous oxide was relegated to use in minor surgical procedures; but the relative merits of chloroform and ether were hotly debated during the whole period. Progress, however, was substantial in techniques of administration and in studies of the anaesthetic process.

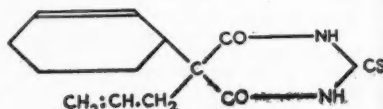
Modern Innovations

In the more recent years of the century have been introduced ethyl chloride for short operations and vinyl ether which resembles it in its anaesthetic applications; ethylene—which has been superseded by cyclopropane; cyclopropane, which is of special value in upper abdominal and intrathoracic surgery; and trichlorethylene, the most recent reception of which has been cautious. These have all challenged but not yet ousted chloroform and ether from their position.

In the last decades of the century under discussion, especially on the European Continent, attention has been concentrated on the injection anaesthetics of the barbiturate and cocaine classes. Of the former "evipan" (hexobarbitone) was the first to be introduced but it has been extensively replaced by "thiopentone" (pentothal). The barbituric acid group of drugs finds its main function in induction of anaesthesia an inhalation anaesthetic being superimposed. Pentothal, formerly a monopoly of a continental firm, is now made in Britain by three different processes which produce the drug in chemically indistinguishable form. Nevertheless it is claimed that there are slight pharmacological differences between the products from each of the three processes.

Within recent months a new thiobarbiturate has been introduced in Britain. It is called "Kemithal" a synonym for the

sodium salt of 5- Δ^2 -cyclohexenyl-5-allyl-2-thiobarbituric acid:—



"Kemithal" is a pale yellow, hygroscopic powder readily soluble in water and with a pH of 10.6 in 10 per cent solution. Developed in an attempt to find an ultra-short-acting barbiturate with a higher safety factor than existing intravenous anaesthetics, it is almost entirely metabolised in the body. It may be used with inhalation anaesthetics or by itself for short or prolonged anaesthesia. For the latter 0.5 to 1.5 grams of sodium "Kemithal" are used for induction with further doses of 0.2 grams if required.

Carrington and Raventos (*Lancet*, 1946) consider that sodium "Kemithal" is half as potent as thiopentone soluble and slightly less active than hexobarbitone soluble. In duration the three drugs hardly differ; in doses sufficient for anaesthesia the respiratory volume is depressed less with "Kemithal" than with thiopentone. The ratio of concentrations in the blood producing arrest of respiratory movement and producing full surgical anaesthesia is greater with "Kemithal" than with thiopentone which suggests less danger of respiratory arrest with the former than with the latter.

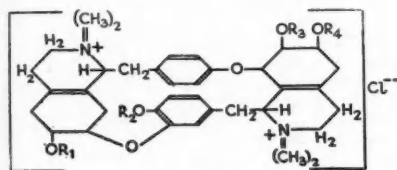
Pure Curare Alkaloid

The past year has seen the full introduction into the armamentarium of the anaesthetist of a pure curare alkaloid, d-turbocurarine chloride, for the purpose of an adjunct to anaesthesia by the use of which relaxation of the abdominal muscles of the patient may be obtained. An extract from species of plants indigenous to South America has long been used as an arrow poison by natives offering the special advantage of paralysing wounded animals in the hunt. The name "curare" was given to a mixture of alkaloids, identified as such by Claude Bernard in 1865, from these plant species.

The effect of drugs with curarising action is to paralyse the skeletal muscles by blocking the nerve impulse at the myoneural junction. The mode of action is believed to be that the drug neutralises the acetylcholine reaction probably by preventing the effector substance in voluntary muscle reacting to the chemical mediator, acetyl-choline.

Because of the extreme toxicity of curare the study of it pharmacologically was much delayed, and it was not until 1934 that Cole (*Lancet*, 1934.3., 457) introduced it for the purpose of control of tetanus convulsions. Much later a new use for the active drug was found for the control of convulsions in electro-convulsive therapy in mental treatment.

In 1935 H. King, at the National Institute for Medical Research isolated the characteristic alkaloid from the mixture of bases in curare and called it d-tubocurarine chloride. (*J. Chem. Soc.*, 1381 (1935); *Chem. Ind.*, 1935, 54, 739; *Nature*, 1935, 135, 469; etc.). The structure assigned was:—



- (A) d-tubocurarine chloride
 $R_1 = \text{CH}_3$; $R_2 = \text{H}$; of R_3 and R_4 , one is H and the other is CH_3
- (B) d-chondocurarine chloride
 $R_1 = \text{CH}_3$; $R_2 = \text{H}$; of R_3 and R_4 , one is H and the other is CH_3 , but in an arrangement which is the reverse of (A).

An American Preparation

In 1940 there was cautiously introduced in North America a curare preparation containing the desirable constituents of curare which possessed a substantially pure curarising action characterised by the paralysis of the skeletal muscles—the intercostal and diaphragm muscles being the last to be affected. The preparation was called "Intocostrin" and its activity was due almost entirely to its d-tubocurarine content which amounted to about half the total alkaloids present. It was first employed in psychiatry to control the convulsions and minimise risk of injury (fractures) occurring in convulsive therapy. Later it was introduced to obtain complete muscular relaxation in anaesthesia by Griffith and Johnson in 1944 (*J. Amer. Med. Ass.*, 1945, 127, 642; *Anesthesiology*, 1942, 3, 418; 1944, 5, 166). Intocostrin is prepared from the desiccated curare extracted from the bark and stems of *Chondodendron tomentosum*, (*J. Amer. Pharm. Ass.*, 1946, 7, 34). This is extracted with alcohol, evaporated to dryness and a sterile solution made at pH 4.6-4.8 which is adjusted to a standard potency of 20 units per cc., the unit being equivalent to 0.15 mg. d-tubocurarine chloride. The final solution has sodium chloride (0.45 per cent) and chlorbutanol (0.05 per cent) added, is steril-

ised by filtration, and has a final pH of 4.6-4.8.

Following the use of the pure alkaloid, d-tubocurarine chloride, as a muscle relaxant by Kellaway (*Lancet*, 1945, 2, 186) it has been made available in this country as an injection during the past twelve months. The drug was originally introduced as "curarine chloride" but to avoid confusion in nomenclature it has now been re-named "d-tubocurarine chloride" (Trevan, *Lancet*, 1946, 2, 361).

Confusion About Origin

There has been some confusion about the precise origin of the curarising drugs largely on account of the fact that earlier isolations and characterisations were performed on museum specimens and from the fact that the drugs fall into three groups of alkaloids, two of which occur in calabash and in tubo curare whilst the third group occurs in the seeds of the species *Erythrina*.

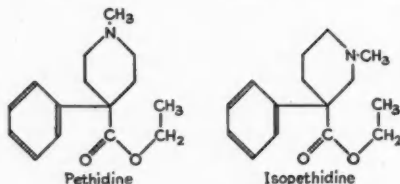
Dutcher (*J. Amer. Chem. Soc.*, 1946, 68, 417) has prepared d-tubocurarine chloride from curare extracted from an authentic specimen of *Chondodendron tomentosum*, Ruiz and Paron (N.O. Menispermaceae). The curare, the concentrated aqueous extract from stems and bark, was a thick brownish paste with a licorice-like aroma and an intensely bitter taste. To preserve it in storage it was converted to a dry powder by vacuum drying and milling. The active quaternary ammonium base was extracted with 1 per cent tartaric acid and the solution treated with basic lead acetate. The lead-free solution was made alkaline with sodium bicarbonate and extracted with chloroform and ether successively to remove the unrequired (mainly tertiary) bases. The aqueous solution was acidified and the d-tubocurarine obtained as reineckate or picrate.

From the tertiary bases separated from d-tubocurarine chloride was obtained a heretofore unknown alkaloid d-chondocurarine which, when its nitrogen atoms were methylated, gave a quaternary base d-chondocurarine. This latter base is represented by formula (B) above. Its importance lies in the fact that it is nearly three times as powerful physiologically as d-tubocurarine.

In doses sufficient to give muscular relaxation the respiratory muscles may be paralysed so that d-tubocurarine must be used with great caution. The effects of the drug are transient due to rapid destruction in the liver and to rapid excretion by the kidneys. "Intocostrin" and d-tubocurarine chloride may be used to advantage with cyclopropane, nitrous oxide, ethylene or sodium pentothal anaesthesia in the lightest plane; but Langton Hewer (*Br. Med. Bull.*, 1946, 4, 110) considers that it should be used only with the greatest caution with

ether which exerts some of the curare effects, and, therefore, in such circumstances, a reduced dose of the curare alkaloid is indicated. In therapeutic dosage d-tubocurarine has an insignificant effect on the central nervous system so that it is neither an anesthetic nor an analgesic. That this is the case in practice has been confirmed by Kellgren *et al.* (*Brit. Med. J.*, 1946, 898).

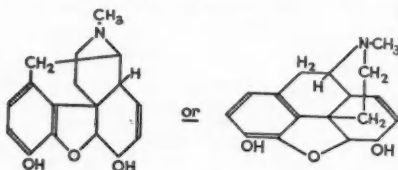
Attention continues to be directed towards the development of analgesic substances which are effective as such and yet are free from the undesirable side-effects of morphine. In the last year or two only one synthetic substance can be said to have found a place in therapeutics and that is pethidine ("demerol" in America) a synonym for the ethyl ester of 4-phenyl-1-methylpiperidine-4-carboxylic acid. (See structural formula below). Pethidine has achieved a monograph in the 7th Addendum (1944) to the British Pharmacopoeia (1932) and because it is a drug of addiction it has been scheduled as a Dangerous Drug. It has, therefore, not succeeded in ousting morphine since freedom from side-effects has not been attained. It has, however, the distinctive feature of being valuable in the relief of pain where spasm of smooth muscle is involved, and it has been recommended for use in obstetrics. The development of pethidine to its present status was referred to by the author in earlier annual reviews.



Macdonald *et alia* (*Brit. J. Pharmacol.*, 1946, 1, 4) report having examined a series of pethidine derivatives prepared according to the methods described by Bergel *et alia* (*J. Chem. Soc.*, 1944). No claims are made that analgesic drugs of importance have been discovered with the possible exception isopethidine (i.e., the 4-phenyl isomer); but the correlation of analgesic effect with chemical constitution within this series is regarded as being important. The findings of these workers supports the theory of Schumann, announced in 1944, that the phenyl-piperidine structure is essential for analgesic activity. In assessing analgesic activity in this series the hot-plate method was used, the plate being held at a surface temperature of 55°C. Analgesia is considered to have been obtained when a mouse to which the drug has been administered on being placed on the plate fails to exhibit the obvious hind leg movement which indicates

discomfort within 30 seconds. From a consideration of their findings regarding the correlation of analgesic effect and chemical structure within this series some speculations have been made regarding certain aspects of the analgesic action of morphine. These speculations are summarised as follows:—

(1) The hydroaromatic ring in morphine which carries the secondary alcohol group and the double bond is replaceable by an open chain consisting of a 4-carboxyl group, a 4-acyl group or a 4-hydroxyacyl group. For maximum analgesic activity the optimum chain length should be four carbon atoms.

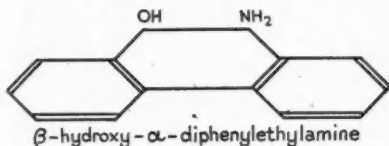


(2) Analgesic activity is not greatly affected by the change of the phenyl group in the pethidine from the 4- to the 3-position; but the ethyl ester is specific. The pharmacological action of the pethidine series is, as usual, associated with the *laevo*-form.

(3) There is a serious loss of analgesic activity if the piperidine ring in the pethidine series is opened; but the activity may be restored to some extent by an additional phenyl group.

(4) Shape and fit of the synthetic analgesic molecule as a whole is more important in obtaining analgesic activity than any precise duplication of any one fraction of the morphine molecule. The more nearly the molecule of the synthetic analgesic approaches the general shape of the morphine molecule the more likely it is to be a good analgesic.

Dodds (*Br. Med. Bull.*, 1946, 4, 88) has summarised the position of the analgesic drug β -hydroxy- α : β -diphenylethylamine



which has been found to be effective in the relief of pain associated with nerve-pressure,—for example, where carcinomatous growths press on nerves. He considers that this drug is not yet suitable for use in clinical medicine at present.

Scott & Chen, (*J. Pharmacol.*, 1946, 87, 63) state that 1:1-diphenyl-1-(dimethylaminoisopropyl)-butanone-2 has a marked analgesic action in rats, dogs and man. They claim that it is at least equal in analgesic power to morphine and several times more potent than demerol (pethidine). It is also mildly antispasmodic. Tolerance does not seem to develop in dogs and side-effects in man are reported to be negligible. Further information regarding clinical trials of this drug will be awaited with interest. Barltrop (*J. Chem. Soc.*, 1946, 958) describes the synthesis of substances modelled on structures implicit in the morphine molecule. The publication of pharmacological results are awaited for assessment.

War-Time Developments

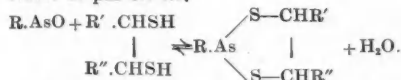
The past year has seen the release of a considerable amount of information regarding drugs developed during the years of war. The information was necessarily withheld for security reasons until recently. Of particular interest is the drug known as BAL (i.e., British Anti-Lewisite) and the new antimalarial drugs.

BAL has already been reviewed by the writer (*see THE CHEMICAL AGE* 17/8/46, p. 195) and the facts already reported will be only briefly recapitulated here. BAL was developed from studies directed towards finding an antidote to the effect of the arsenical war gas, Lewisite. Its applications appear to be wider, since the group of drugs evolved, of which BAL is the most efficient, have therapeutic value in arsenic intoxication whatever the source of the arsenic. A frequent source of arsenic poisoning is in the treatment of trypanosome infections such as syphilis when organic arsenicals are used.

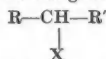
It was first necessary to elucidate the mode of action of arsenic poisoning. Indeed, this had been proceeding steadily during the inter-war years and took on a new urgency in the early months of the last war. It had become quite clear that arsenic acted through inhibition of enzyme systems and that the pyruvate-oxidase enzyme was especially sensitive. The pyruvate-oxidase enzyme system of pigeon brain was especially suitable as a "measuring-stick" for the assessment of possible antidotes to the arsenicals which inhibited the enzyme, since it was highly sensitive to arsenic poisoning when respiring in air in Ringer's phosphate solution at pH 7.3 and at 38°C.

In general it was found that dithiols were able to form stable ring systems with arsenic which were more stable than the complex formed between arsenic and the tissue substances. Moreover, the characteristics of the suitable dithiols when in combination with arsenic were such that tissue-fixed arsenic preferentially combined with them and in such combination were readily excreted from the system. The most success-

ful drug was found to be BAL—British Anti-Lewisite, dithioglycerol or 2:3-dimercaptopropanol,—a dithiol which is able to form a stable ring system with arsenic so that, on injection, the arsenic partitions itself between the tissues and the drug, but in favour of the latter. The ring system is stable at pH 8.0-8.5.



The classical method of producing dithiols is that of Carius (*Ann. der Chem.*, 122, 71; 124, 221) in which a chlorhydrin is heated with an excess of potassium hydrosulphide in alcoholic solution, the yields being poor. According to Pratt, Peters, Stocken and Thompson (*B.P.* 579,971) improved yields are obtained when the process depends upon a reaction between alkali hydrosulphides and compounds of the general formula



In which R is H, alkyl or analkyl; and R' is—CX (R₂), or—C (R₂).CX (R₂) where X denotes halogen.

The method depends upon the known reaction $\text{R.Br.} + \text{NaSH} \rightleftharpoons \text{R.SH} + \text{NaBr}$. But since $2 \text{NaSH} \rightleftharpoons \text{Na}_2\text{S} + \text{H}_2\text{S}$ conditions must exist such as a low temperature or a closed system at a higher temperature in order to prevent the dissociation of NaSH. The reaction is, therefore, carried out at room temperature for several days, or at 30-50°C. under pressure of hydrogen sulphide for 30-72 hours.

2:3-dimercaptopropanol or BAL is prepared by allowing 2:3-dibromo propanol and an alcoholic solution of sodium hydrosulphide to stand for a week. Salt is precipitated on acidifying, is filtered off and alcohol and water removed by distillation under reduced pressure. The dithiol is extracted with chloroform, the solvent removed and the residue distilled at low pressure. BAL is obtained at 65 per cent theoretical yield; M.P. 77°C.; B.P. 95°C./1.0 mm.

Non-Toxic Effects

McCance and Widdowson (*Nature*, 1946, 157, 837) found BAL essentially non-toxic to man and paid particular attention to the excretion of heavy metals other than arsenic, which are present in the body, during treatment. They found that the drug increased the excretion of copper twenty times; of zinc about five times; of iron not at all. McDonald (*Nature*, 1946, 157, 837) applied these findings to sheep suffering from excessive retention of copper which leads to toxic jaundice. Administration of BAL-Intrav (a solution of the O-glucoside or dithioglycerol)

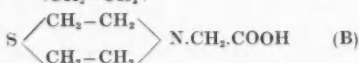
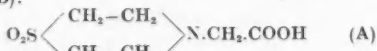
led to the excretion of copper at the rate of thirty times normal.

Parallel with the study of the action of dithiols on arsenic-protein complexes by Peters and his co-workers Wormall (*Biochem. J.*, 1946, 40, xlvii) has studied the action of mustard gas (M.G.) on the tissue proteins. He confirms that M.G. reacts readily with serum proteins, nucleoprotein, keratine and collagen under physiological conditions to give complexes from which it cannot be recovered by long extraction with ethanol, acetone or other solvents. Wormall found that using radio-active sulphur (S^{35}), the iodine-titratable thiol of the protein was reduced after treatment with M.G., but this accounted for only a small part of the reacted substances; also there was no extensive reaction with amino groups; but there was a rapid reaction between mustard gas sulphone and protein amino groups. About 23 molecules of mustard gas were found to combine with one molecule protein assuming a mean molecular weight of serum proteins of 100,000.

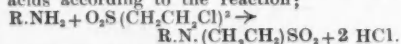
Using radio-active sulphur injected into rabbits at the rate of 5 mg. mustard gas per kilo body weight, Wormall found diffusion from the blood stream to be very rapid. M.G. accumulated in the highest concentrations in excretory organs such as kidney lung and liver and it was not extractable from the tissues of these organs by the normal M.G. solvents. It was presumed, therefore, to be fixed in the tissues as a protein-complex resembling the experimental type described above.

Wormall's Tests

Wormall also carried out serological tests with mustard gas—and mustard gas sulphone-amino acid compounds in order to obtain information on the immunologically active groups of M.G.—and M.G.-sulphone protein antigens. Complete inhibition of the precipitin reaction between M.G.-sulphone-proteins and antisera to sulphone-proteins were inhibited by "sulphone-glycine" (A) and "sulphone-alanine" but it was only partial with "M.G.-glycine" (B).



which demonstrates the very marked difference between mustard gas and mustard gas sulphone on proteins. It would seem that the reaction of mustard-gas-sulphone with proteins is largely concerned with free amino acids according to the reaction;



(NOTE: Since the manuscript of this

Review was prepared the work on mustard gas has been published *in extenso* in a series of monographs. See *Biochem. J.*, 1946, 40, p. 734 et seq.)

The organic arsenicals still remain of supreme therapeutic importance and in studies of the metabolism of phenylarsenious and phenylarsenic acids it is desirable to effect quantitative separation between tri- and penta-valent arsenic. Sodium ethylxanthate is effective for the separation of simple arsenic compounds, but fails to distinguish between the phenyl derivatives. Crawford and Levy (*Biochem. J.* 1946, 40, 455) found BAL to be unsatisfactory; but they found another dithiol, ethane-1:2-dithiol, in carbon tetrachloride to be satisfactory for separating the phenyl derivatives of tri- and penta-valent arsenic.

London Wages Dispute

Sequel to New Agreement

SOME unrest in the fine chemicals industry in the London area is reported this week to have resulted from the terms of a wage agreement recently concluded by the Drug and Fine Chemical Trades Joint Committee, consisting of the Association of Chemical and Allied Employers and the Drug and Fine Chemical Manufacturers' Association and the negotiating body for London workers, comprising the Transport and General Workers' Union, the National Union of General and Municipal Workers and the National Union of Distributive and Allied Workers. By the terms of this agreement a "London differential" was established granting to adult male workers in the London area (within 15 miles of Charing Cross) a wage increase of 1d. per hour 4s. per week) and to women and juniors 3d. per hour.

It is claimed by the workers that by the terms of this agreement employers concerned were empowered to include in the new basic rate any additional weekly payments freely granted in the past, and it is stated that a few manufacturers have done this on the first pay day in January, when the new rate took effect. Strong dissatisfaction was reported to prevail in one or two quarters of the industry in London this week, but threats of sit-down strikes had not been implemented. The Chemical Workers' Union, formerly the negotiating body for these workers, is to call a meeting on January 18 or 19 with a view, it is understood, to having the operation of the new agreement—to the detriment of some existing privileges—submitted to arbitration.

Large salt deposits have been discovered in Jutland during petroleum drilling operations.

METALLURGICAL ADVANCES

by A. G. AREND

ALTHOUGH the year 1946 has perhaps not seen entirely fresh basic scientific attainments such as those associated with uranium in 1945, industrial progress has been made in the metallurgical industries generally in almost all directions. What has been termed Atomic Year 1, may not readily find a successor of equivalent importance for some time, although every effort is being made to expand nuclear researches and turn them to account for industrial service conditions. A number of societies have been engaged on correlating the indexes of scientific literature, with a view to saving the time of research workers, and firms interested in the development of fresh processes. While this is very valuable in indicating the trend which previous work has taken, it is frequently very remote from actual practical application. The student is reminded when searching abstracts, and particularly those of extraction methods, that details of some metals have been given very freely, whereas others have been confined to a certain secrecy.

For example, practically all particulars have been given of the different stages in extracting, smelting, and refining (including electro-refining) of copper, lead, zinc, gold and silver, while iron and steel processes are described in the most minute detail. The same cannot be said of aluminium, tin, nickel, cobalt, and a number of the ferro-alloys and rarer metals, although elaborate information is available on their uses and industrial possibilities. With aluminium, magnesium, and most of the ferro-alloys, the electro-thermal processes are of a more or less direct order, and privacy more relates to means of acquiring the maximum extraction with minimum current consumption, but the others, when recovered from ores of a complex nature, offer many hazards. In this connection, one patent agent remarked that it was doubtful if more than somewhere in the region of 10 per cent of proposed extraction processes were ever put into use, which indicates the need for care in studying "claims" which have been put forward in this literature.

Extended Uses for Metals

Methods which have, however, enjoyed successful practical implementation during 1946 are seen in the link-up of aluminothermy, or "thermit" process, with modern casting, using the selected waxes and low-melting point alloys as introduced in 1945. This means that besides being enabled to rapidly turn out a cast part without subsequent dressing, etc., repairs can be directly

made on existing plant without the need for dismantling.

Magnesium, which is now in greater supply than demand since the war stopped, has been turned to a unique use in connection with pipe-lines, where, in the capacity of an anode, a cast magnesium cylinder provides "cathodic" protection. Where zinc was previously tried for this purpose it tended to polarise gradually as time went on, besides only giving a driving voltage of from 0.4 to 0.5 volts against iron, and was only of academic interest. Magnesium, on the other hand, shows no corresponding polarisation, and possesses a driving voltage against the iron pipe of 1.0 volt. The use of springs at temperatures up to a red heat was a thing unknown in the past, but to-day specialised metals have made it possible for the good spring properties to be retained, and which it is expected will be put into service for different fabricating processes. One composition used for this purpose comprises a steel with 12 per cent chromium, 8 per cent nickel, and 1 per cent beryllium, and which besides possessing high-temperature oxidation, may be age-hardened at some 1350°F.

Thorium

Thorium, of which an account recently appeared regarding modern extraction methods, is to-day used for increasing the life of electrical resistance alloys, where it is added at various small quantities, up to 2 per cent, to the familiar 80 per cent nickel, 20 per cent chromium composition. Beyond 2 per cent of thorium, the useful span of life could be still further extended, but the metal was difficult to work, and was not persevered with. At 2000°F. the life of the alloy could be increased five or six-fold, and a measure of this will be gathered from the following percentages. Wire with 0.02 per cent thorium at 1920°F. shewed a 75 hour life, with 0.1 per cent, 140 hours, with 1 per cent, 325 hours, and with 2 per cent, 400 hours, which reveals that if the thorium itself could be obtained more economically, it would enjoy extended uses for various industrial and domestic appliances. Specialised additions to aluminium are seen in the inclusion of lithium to render sheets stiff, and beryllium to make the metal harder and more wear-resistant, and which latter is likewise used to improve the properties of nickel. For the more exacting heat-treatment of steel, lithium is to-day vaporised within the furnace in sufficient quantity to absorb all water vapour and oxygen, so that an entirely neutral protective atmosphere is assured.

The advent of the jet engine and internal-combustion turbine generally has made more demands on high-temperature alloys than on almost any other industrial project, with the exception of mechanically-operated hearths; in fact, successful designing of these more depends on selection of the proper materials than on any other feature. Columbium is considered to be one of the best metals for this purpose, but like tantalum, is limited to some extent because of price restrictions.

Some of the latest high-grade stainless steels containing molybdenum can function with precision at 1500°F. and a stress or pressure of up to 15,000 lb. per square inch. Whereas formerly little more than about 100 hours of service could be obtained before some form of breakdown occurred, under the same conditions, some 9000 hours of service can to-day be enjoyed. During 1946, some divergence of opinion existed as to whether the cobalt and nickel base alloys, or the iron base alloys, were best suited for this work.

One of the former types used comprised from 40 to 50 per cent nickel, 20 to 30 per cent cobalt, 15 to 30 per cent chromium, 5 to 15 per cent iron, and 1 to 4 per cent titanium. Another consisted of 65 per cent cobalt, 30 per cent chromium, and 5 per cent molybdenum, while tungsten-bearing Stellites were also introduced. A third type consisted of 75 per cent nickel, 14 per cent chromium, 6 per cent iron, 3 per cent titanium, and 0.6 per cent aluminium. Of the steels, those containing either 18 per cent chromium, and 8 per cent nickel, or 19 per cent chromium and 9 per cent nickel, with varying additions of tungsten and molybdenum, are mainly preferred. The decision which to use is largely dependent upon what fabrication and weld-

ing will be necessary. The major problem with any of these is the dimensional stability at high temperatures, and load-bearing strength, but which has not yet been solved by any one alloy in particular. At the moment, those of the cobalt-base types are perhaps ideal from the dimensional stability standpoint, but are not so strong, whereas the special steels possess ideal strength at high temperatures, but are not so stable dimensionally. Much attention has also been devoted to alternative compositions of alloy steels containing 25 per cent nickel, 16 per cent chromium, and 6 per cent molybdenum. These are claimed to be up to 3 times as strong as the stainless steels at 1500°F. while the stress required to produce a given rate of creep approximates to more than twice that of the latter.

Thus it remains to be seen what fresh improvements will accrue in 1947 in correlating the information so far gathered, so that turbo-superchargers, gas turbines, and jet engines, will be enabled to produce the maximum output for lengthy periods, without deterioration. The less vulnerable parts of these mechanisms are made of grey iron, but which is also turned out of the highest grades.

In the steel industry, researches are still proceeding in attempts at automatic control of the process, and although fraught with many practical difficulties, these indicate that what for long was regarded as a highly skilled operation, may yet be carried out without the need for human aid. Various forms of improved instruments introduced prior to 1946 showed means of acquiring composition results almost immediately, such as the spectrograph, Spekker, or ramifications of the polarograph, but these could not

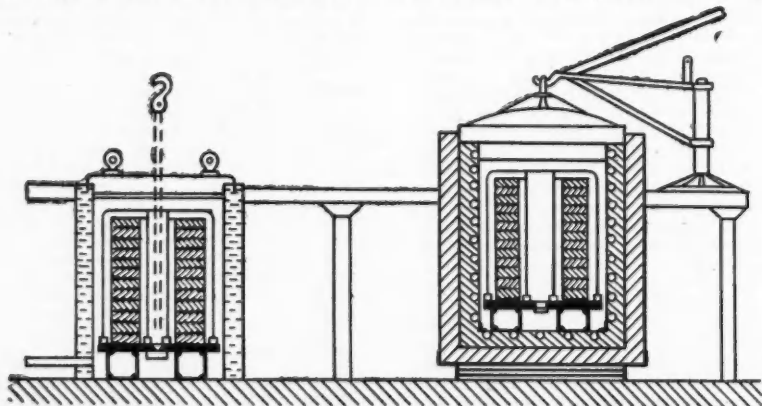


Fig. 1. Design of modern heat-treatment furnace wherein lithium is vaporised to absorb all watery vapour and oxygen, to ensure an entirely protective atmosphere

deal with the molten metal. In the latest "X"-ray technique, however, a beam is shot through the mass without interference, using proto-tubes of the multiplier types, and with the assistance of selected vibration and acoustic changes, which are enormously amplified, are thought capable of accounting for the "pipe" carbon content, and control of other constituents, as a continuous cycle. Other improvements of a constructional order are with a view to expediting any expansion of modern plants which are fed directly with raw iron from the blast furnace, by the arrangement of rail tracks and conveyors to meet the immediate needs of mixer and open hearths. Attempts at obviating the use of the chimney (a distinctive landmark in most steel districts) have not so far succeeded. These were carried out on the large scale by substituting a fresh exhaust system with automatic regulation, and utilising all waste heat, but this had to be dismantled, and the chimneys re-erected.

Tilting open-hearth furnaces simplify slag removal where much raw iron has to be handled directly, dolomite fettling machines are now more popular, and the recovery of phosphate slag is sometimes dispensed with, where the steel is made more economically from pig-iron containing only 0.15 per cent of phosphorus. Revolving grate producers with utilisation of all waste hot water from the surrounding jackets for welfare department baths, is another innovation. Valves and gas lines are arranged to provide the proper combustible gas of known calorific value to furnaces automatically, although this is obtained from three sources, namely, the producers, the coke ovens, and blast-furnaces.

Although relatively little information comes to hand, it is known that Swedish metallurgists are improving on the direct electric smelting of iron ores containing sulphur. In one instance in this country, a housing site is being erected on a dump containing burnt pyrites, which, because

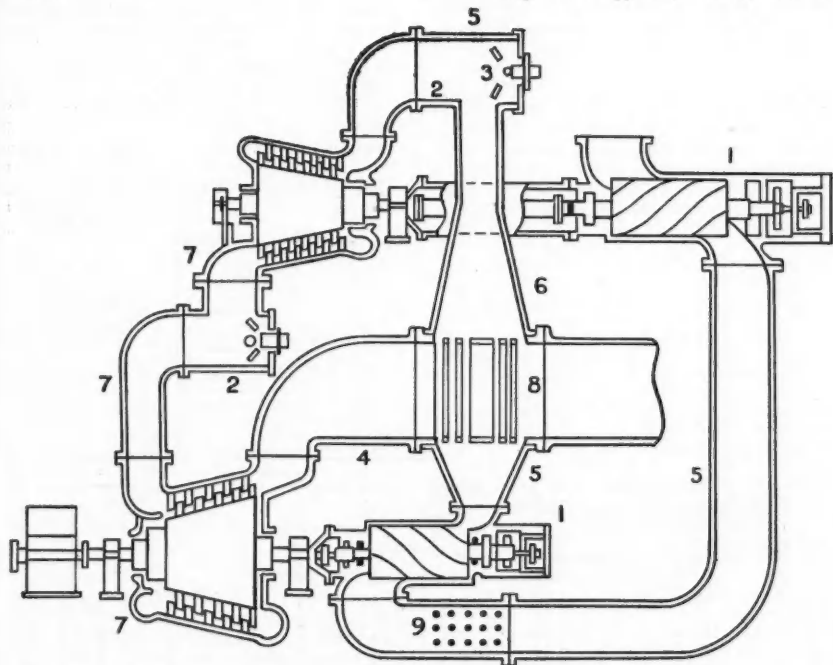


Fig. 2. Metals used in the construction of the modern jet engine include: 1. Grey iron. 2. 28% chrome steel. 3. 25/20 chrome-nickel steel. 4. 18/8 chrome-nickel steel. 5. Carbon steel. 6. Chrome-molybdenum steel. 7. Special steel. 8. Nickel tubes. 9. A.G.M. tubes. In other arrangements, cobalt-chrome, nickel-chrome, and tungsten Stellite alloys are used, with or without additions of molybdenum, and titanium.

some sulphur still remains, is considered worthless. Although induction heating made great progress during the war, the costs were sometimes considered somewhat heavy, and although applied to the shrinking of certain parts, has been competed with by more judicious use of a controlled gas and air mixture. For example, wheel tyres can have a diameter enlarged by 0.08 inch by the consumption of 32 feet of gas per foot of tyre diameter, in from 12 to 15 minutes, according to the size of the tyre. This makes it difficult for the electrical method to compete with it, in view of the costs of the outfit, and existing current prices.

Hardness of Sheet Metal

In other directions, recent developments in atomic or nuclea researches have attracted attention to the defects in determining the hardness of sheet metal, since on the one hand, the surface is either indented, or alternatively, scratched. The fact that the interior has its structure crushed or impaired by this treatment has only to-day been fully appreciated, but the true meaning of hardness still remains a mystery. It is recognised that those who understand all features of how mechanical obstruction to the slipping of planes intensifies distortion, will hold an appreciable lead over competitor firms in the matter of rolling practice. Accordingly, fresh instruments are still required to gather a really true criterion. In wet processes, exceedingly aqueous solutions, which formerly

were thrown out as so much waste, have their metal values extracted by passage through selected synthetic resins.

This has now been further amplified by the use of modern refrigeration methods so as rapidly to solidify the surplus liquid matter, since the salts are thereby left in solution. The number of B.Th.U's required is a mere fraction of that necessary by evaporation, and is sometimes not more than one-eighth, which frequently more than justifies the otherwise more expensive refrigerating installation. Specific gravities of solutions were not readily determined automatically until this past year, when advantage was taken of a simple principle. By applying the same vacuum to two legs of an instrument, one of which contains water, and the other connected to the sample, the difference in height caused by the suction gives a result, but it is not known if this instrument has as yet been placed on the market. In the laboratory, efforts have been made to revive a much earlier suggestion to substitute black enamelled basins for the traditional white porcelain basins. Unless the chemist has good eyes, and good light, minute particles of white precipitates are liable to escape observation.

The latest enamel compositions have not been divulged, but those in use comprise 3 per cent cobalt oxide, 2 per cent manganese oxide, and 2 per cent of brown chromate of iron, which gives a glazed surface impervious to attack from the vast majority of solutions.

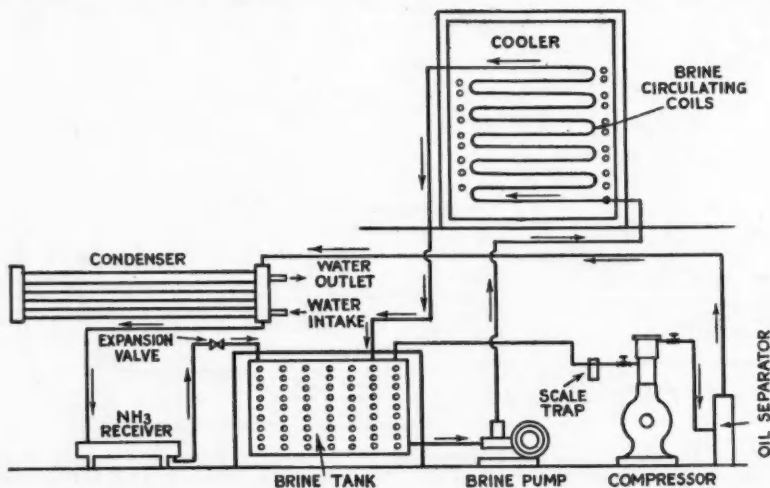


Fig. 3. Main items in a refrigerator lay-out, which to-day acts as an important supplement to the use of synthetic resins in recovering minute quantities of metals, by rapidly getting rid of surplus water.

SOME RECENT WORK IN COLLOID SCIENCE

by W. H. BANKS, Ph.D.

CONTINUING the accurate studies on streaming potentials (reported here last year), L. A. Wood (*J.A.C.S.*, 1946, 432) reaffirms the clarity of the Helmholtz description of electro-kinetic effects in terms of the concept of a moment of the electrical double layer. This concept is more fundamental than the ζ potential. In streaming potential measurements, what is really measured is a moment given by $\eta Ek/p$, (η = viscosity, E = potential gradient, p = pressure gradient, k = average specific conductance). It is only possible to deduce ζ potentials from measurements of streaming potentials ($\zeta = -\text{moment} \times 4\pi/\text{Dielectric Constant}$) if one makes a number of assumptions additional to taking the value for the dielectric constant of the bulk solution as that in the region of the double layer.

If the tube radius is small then the approximate formula for streaming potential (derived from Poiseuille's law of flow) breaks down and it is shown that the moment bears a relation to tube radius (a) of the form $\eta Ek/p = \text{moment} - \frac{A}{a}$ and this is illustrated by the data of Bull and Gortner on powdered quartz membranes.

Measurements on Water

The same author (*J.A.C.S.*, 1946, 437) measures the streaming potentials for the pure water/vitreous silica system. Forty-eight measurements on water ($k = 0.2 - 0.4 \text{ mhos} \times 10^{-6}$) show variations larger than experimental error. ζ generally falls and one sample of water changed from -200 m.V. to -177 m.V. in six days. A value in this region is consistent with a value extrapolated from the data on KCl solutions previously reported by this author and Grinnell Jones. The time changes are probably due to swelling of the silica by water. The outcome of all this accurate work is to show that, contrary to past measurements, the ζ potential of KCl/water systems do not pass through a maximum with increasing concentration. In this connection the measurements of A. J. Rutgers and M. De Smet (*Trans. Farad. Soc.*, 1945, 758) are important. These authors calculate the ζ potential of a number of solutions from electro-endosmotic measurements made in a number of capillary tubes covering a 2.5 fold range of size.

For electrolytes with uni-valent cations the $\zeta - \log C$ curves are all of the same character except for HNO_3 and KOH . For these latter the glass wall behaves in some

respects as a H^+ electrode. For divalent cations the glass behaves as a perfect cation electrode (linear $\zeta - \log C$ curves with a slope of 25 to 26 m.V.).

It is well known that a liquid drop falls faster in a liquid than a corresponding solid sphere because the drag at the surface in the latter case is dissipated by induced motion in the liquid drop. A. Frunkin and B. Levish discuss the modifications brought about if drops of mercury move in solutions of electrolytes (*Acta Phys.*, U.S.S.R., 1946, xxi, 193). A moving mercury drop will tend to accumulate ions at its rear end. These ions modify the interfacial tension so as to prevent the induced motion, thereby reducing the motion of the drop and tending to make it move as slowly as a solid sphere. In general, the unequal distribution of ions will tend to be evened up by conduction through the surrounding electrolyte. These considerations are of importance to the development of polarography, and the classical treatment of Ilkovic in which a growing mercury drop is regarded as doing so radially (i.e., like an expanding balloon) is, of course, incorrect on account of these surface eddy movements. The eddy motions can, according to these authors, give rise to additional maxima in polarographic curves. Dealing with the same theme, A. Frunkin discusses (*J. Coll. Sci.*, 1946, 277) the Christiansen phenomenon but in addition points out new phenomena. If mercury is dropping from a tip in an electric field the size of the drops can be made very small, and if, for example, positively charged drops fall into the vicinity of a cathode they strike it and bounce off having their charge revised. In this paper reference is made to the work of Rehinder on the influence of an electrical double layer on the hardness of metals. The hardness is lowered because the lowering of the interfacial tension by the double layer results in a weakening of the surface cracks which characterise all solids. The results show hardness (measured presumably by amplitude of a pendulum pivoted on the metal) as a function of the polarisation of the metal. The maximum hardness occurs at the polarising e.m.f. corresponding to the maximum of the electro-capillary curve for the metal.

Shrinking and Cracking of Cements

A symposium of great practical importance was held by the Roads and Building Materials Group of the Society of Chemical Industry in May, 1946. The subjects dealt with concerned the shrinkage of such mate-

rials as cements, concrete, plaster. According to L'Hermite, the spaces between crystals of hydrated cement are held in tension by capillary held water and thus stresses arise when the material dries out. In this way shrinkage is related to the volume compressibility of the drying solid.

Baugham regards the dimensional changes in presence of vapours as due to a displacement of an equilibrium thought to exist between the elastic forces (tending to expand the solid) and forces (tending to contract) at the surface of all solids. His view is that capillarity has little to do with the matter since surface forces are of much greater magnitude. In fact, he states that while the surface energy of water is some 70 ergs/cm², solids may have values as high as 1000 times this figure and adsorption of water vapour will reduce this value very considerably to one which allows the elastic forces to operate.

Some Useful Techniques

F. K. Daniel and P. Goldman (*Ind. Eng. Chem. (Anal.)*, 1946, 26) describe a series of qualitative tests which it is claimed assist in evaluating the degree of dispersion of powders in liquids. The dry powder is mixed with the dispersing solution and the flow properties of the mix are examined qualitatively, e.g., a good dispersion will give active dilatancy at high powder concentrations. Poor dispersion results in plasticity over a range of pigmentations. Fair dispersion shows itself as passive dilatancy at high pigmentation and thixotropy at lower powder concentration. The tests described are probably useful industrially as a first step to more quantitative examination; but in the reviewer's opinion dangerous as sole evidence. They are probably useful under standardised conditions as, for example, exist in cases where one is comparing various dispersing agents for a given powder and liquid. R. L. Stoker (*J. Appl. Phys.*, 1946, 243) describes an interesting method of determining the size of droplets dispersed in a gas by using the fact that a droplet on striking a plane surface which it does not wet, suffers deformation and has momentarily a large area of contact. The drop is allowed to flatten itself against a sooty surface. The dimensions of the mark which it leaves are shown empirically to be related to the surface tension, density and diameter of the drop. Tests are described for water and mercury drops.

Morey and Tamblin (*Journ. Phys. Chem.*, 1946, 12) discuss the effect of initial concentration and choice of solvent and precipitant in fractionating high polymers.

H. P. Gregor and K. Sollner (*Journ. Phys. Chem.*, 1946, 53; 88) discuss improved methods of preparing colloidal membranes showing high permeability and extreme ionic selectivity.

Melville and others (*Nature*, 1946, 74) describe the production of a variety of bacterial cellulose which can be fabricated as a membrane for osmotic work in the field of high polymers. It is prepared from *Acetobacter xylinum* and the membranes have a high enough permeability to make for relatively rapid osmotic equilibria in cases where ordinary membrane material is far too slow.

E. D. Hauser and D. S. Le Beau (*Ind. Eng. Chem.*, 1946, 335) describe a microscope technique in which ultra illumination by incident light is used. It allows circular illumination of the specimen by incident light which does not pass through the objective lens as in classical technique. The light can be focussed independently of the focal distance of the optical system, thus allowing illumination of the specimen in a way best suited for its surface configuration, and prevents light scattering and loss of detail. Photographs are shown of samples of rubber deposited from solution in which the film is stretched across the open pores of a small scale gauze (magnification 2500 diameters). Soap films are shown at 4000 diameters and the fibrous structure so revealed, and which is usually characteristic of soaps, compares well with electron micrographs of sodium oleate.

Swelling and shrinking was a subject of discussion by the Faraday Society during September (some 30 papers). The swelling and shrinking of solids falls very generally into two classes, depending as it does on changes in the spacial relationship of ions on the one hand and molecules, especially macro-molecules, on the other. In the latter case (e.g., rubber in organic liquid) the swelling arises through a change in the configuration of a large molecule which can assume all configurations between the extremes of a coiled-up state and fully stretched condition depending on the interaction with the solvent molecules. In case of ionic systems (e.g., swelling of clays in water and salt solution) the changes in volume arise through the movement apart of charged ions and their ionic atmospheres.

Swelling of Polymeric Material

The problem of the swelling of polymeric material (an important one in the plastics industry) still remains largely unsolved although the problem can at least be defined accurately. It is to calculate the number of ways in which a molecule such as rubber, consisting of a large number of CH₂ groups all joined by "flexible" links, can be placed among the solvent molecules. Given the answer, we can then derive the heat of dilution and related quantities which determine such technologically important properties as swellability and choice of solvent.

Gee shows that the statistical calculation of Huggins (1942) is not very successful when applied to rubber. His analysis shows,

however, the direction in which the statistics must be improved. A necessary adjunct to this work is knowledge of the degree of "coiled-upness" of these molecules, and the way the solvent affects this; accordingly, Doty discussed how measurement of the turbidity of high polymer solutions can give some idea of the extent to which the molecules become stretched in different solvents. Here the theory of the optical principles is by no means complete, but the method proves promising because by calibration it can become largely independent of optical theory. Again, similar information was shown by Alfrey to be obtainable from measurement of the viscosities of solutions.

Molecular networks of flexible linear macro-molecules consist essentially of network structures with fixed junction points either of a chemical or physical nature, and when stretched mechanically or swollen by imbibition of liquid, deformation of the chains takes place. If the swelling is unidirectional the material becomes double refracting and Hermans and Verman discuss this aspect of the swelling of cellulose fibres. In this connection too, Hartley and Robinson describe experiments showing the diffusion of acetone into cellulose nitrate and the consequent movement of the swollen solid outwards prior to dissolving. This outward movement results in a uni-directional orientation of the molecules of polymer just as would result from uni-direction stretching; a simple microscope technique is described for studying the kinetics of such processes.

Gels and Liquid Uptake

From a strictly phenomenological point of view it is unnecessary to consider molecular mechanism in describing the effect of mechanical restraint on the uptake of liquid by a gel; for, given the elastic constants, and the imbibition at a given temperature and stress, this defines the state of affairs under other given conditions. Barkas in a very rigid piece of thermo-dynamics has given the fundamental equations, which although perfectly general, were worked out for the wood/water system. This very complete and exact work is described in an earlier report and would repay study by all workers in these fields. By contrast Hailwood and Horrobin consider detailed mechanism and show that the swelling of textile fibres over a large range of relative humidity can be described in terms of sorbed water existing partly as hydrated textile and free water in solid solution. It is necessary to assume in addition that only part of this fibre molecule is accessible to the hydrating water; the other part is organised in a crystal-like fashion. This view of co-existing amorphous and crystal parts of a polymer is not new, of course, but was supported by Hermans, who discussed the structure and deformation

of cellulose gels. The same view is employed by Peitpas and Mathieu who discuss two types of swelling in nitro-cellulose.

An ingenious method of studying the transverse swelling of fibres is described by Preston. The fibres are packed into a tube and a free space filled with electrolyte. The electrical conductivity is dependent on the cross section of the space filled with electrolyte. By comparison with measurements made on the tube filled completely with electrolyte it is possible to obtain the average cross section of the fibres in the swollen condition.

Swelling by Electrolytes

The ultimate explanation of the action of electrolytes in causing swelling of materials consisting of ionogenic groups (as in clays and proteins) depends on an understanding of the forces between ionic layers. The necessary theory is still a matter of uncertainty. The well known observations of Zocher (1925) on the sedimentation of plate-like particles of Fe_2O_3 to a definite spacial separation of 8000\AA and the recently established uniform separation of 100\AA shown by soap micelles (Mattoon, Harkins, and Corrin, *J.A.C.S.*, 1946, 220), also the older observation of Bernal and Faneuchen on the hexagonal arrangement of tobacco mosaic virus, all afford strong appeal for the development of theory to account for forces acting over a wide range of distances. Levene maintains that consideration of electrostatic interaction of double layers does lead to stability of particles at a finite separation. In contrast, Verwey and Overbeck claim that repulsion will exist at all separations if London forces (attractive) are not taken into account. These forces, depending on the inverse sixth power of distance, normally become unimportant between individual molecules beyond molecular distances, but for parallel plates they depend on the inverse second power and can assume importance when superimposed on coulombic forces. It is clear, however, that the whole theory is still undeveloped, for Levene's theory requires the effect to become manifest at distances very much smaller than observed, while Overbeck's theory shows that at the distances commonly observed the nett attractive energy is only of the order of KT , i.e., not sufficient to outbalance the disruptive Brownian movement.

An interesting technical paper by Barwell Pepper discussed the swelling of reinforced plastics by water.

The extensive data reported by D. J. Lloyd and co-workers on the swelling of protein fibres in a range of solvents other than water is discussed from the point of view of interaction between various active groups in the protein and the penetrating solvent.

Discussion on swelling in the biological field showed that much remains to be ex-

plained in the osmotic phenomena occurring in cells. On the simplest view a red cell may be treated as a balloon-like body surrounded by a semipermeable membrane. Taking into account the elastic properties of this membrane it should be possible to relate the volume of this cell in different environments from osmotic pressure calculations, but experimentally such calculations are not always borne out.

Micelle-forming Compounds

In recent years evidence for the presence of micelles in solutions containing soap-like materials has been sought in a more direct way than by methods previously used, for example, in the well-known work of McBain and G. S. Hartley, who made use of electrical conductivity, and osmotic properties. The use of X-rays for elucidating the structure of the micelles originated in Germany about 1939 (Stauff, Hess, Kiesig and Philipoff) and the evidence suggested a lamellar form of micelle as distinct from the classical spherical micelle. This sort of work has been extended and a recent detailed study by Harkins, Mattoon and Corrin (*J.A.C.S.*, 1946, 220) on solutions of the sodium and potassium salts of long chain fatty acids is of great interest. They suggest that the micelle consists of double layers of oriented soap molecules in between which is sandwiched water. In the layers, the hydrocarbon chains are orientated towards one another with the polar group toward the water. The micellar spacings vary from 30 Å to 100 Å and the addition of salts results in modification of these spacings.

Although micelle formation is generally accepted as accounting for the rather abrupt changes in properties which occur over narrow ranges of concentration, controversy still exists as to whether aggregates exist at concentration below that at which these marked changes occur (sometimes referred to as the critical concentration). For this reason evidence of a direct character is valuable and M. L. Corrin, H. B. Klevens and W. D. Harkins (*J. Chem. Phys.* 1946, 14, 480) report work to this end. Solutions of the dye, pinacyanol chloride, exhibits absorption spectra which are markedly dependent on whether the solvent is water or non-ionising and these authors suggest that in a soap solution where no micelles are present this dye will show the "aqueous" spectrum, whereas if any quantity is associated with the micelle (in the Hartley sense or what McBain refers to as solubilisation) it will exhibit the spectra characteristic of solution in non-ionising media. The outcome of the experiments is to show that above certain soap concentrations the spectrum does become predominantly "organic" and the concentration of soap at which this happens agrees in order with accepted values deduced indirectly. Unfortunately the work

was not entirely conclusive as to the existence of aggregation at concentrations lower than the critical. The solubility in water of paraffin chain salts, such as sodium cetane sulphonate, varies markedly with temperature. Below a certain fairly well defined temperature the solubility is small and changes very slowly with temperature change. Above this, the solubility increases markedly, e.g., a solubility under 0.1 per cent changes to 50 per cent or more in a range of 10°C. Adam and Parkhurst (*Trans. Farad. Soc.* 1946, 523) record measurements on some typical salts and explain the observation by the formation of micelles which are very much more soluble in water than the single unaggregated ions.

This micelle formation can obviously only occur at a temperature where enough single ions are present to exceed the critical concentration for their formation.

Copper Development

Association's Annual Report

PLANs for a considerable expansion of the Copper Development Association's activities have been put into effect, it is stated in the association's annual report. Considerably more work is now being undertaken, with satisfactory results, than at any time before.

The new headquarters at Kendals Hall, Radlett, the report adds, have been operating throughout the year and have proved very satisfactory. As envisaged in the first stage of the planned expansion, they are now practically complete, including the workshop, and a cordial invitation to visit them is extended to all members. A number of appointments have been made during the year and the staff has been considerably enlarged.

To ensure efficient distribution of the Association's publication, the mailing list is being overhauled and brought up-to-date. Any firm or individual with a genuine interest in applications of copper and its alloys is invited to apply for inclusion in this list. The Association's technical records have continued to expand and they already comprise one of the most valuable collections in existence of selected technical information on copper and its many applications.

Continued attention was given to the development of the uses of copper salts for various purposes. In particular, the horticultural and agricultural applications of such salts were further investigated and information collected for inclusion in a comprehensive book on the subject which is nearing completion and is to be published.

Many chemical problems, including those relating to corrosion, were investigated. Some involved close co-operation with the British Non-Ferrous Metals Research Association.

FUEL TECHNOLOGY IN 1946

by G. E. FOXWELL

THE year that has just passed has been momentous in its implications and occurrences in the domain of fuel. It is common knowledge to all fuel technologists that coal is the basis of every industry and is the source from whence is derived whatever power this country possesses in the councils of the world. There is no industry which does not require heat or power for one purpose or another. The mechanised power used in this country is a good deal less per head of the population than it is in America and it is evident that if we are to increase the production per man-hour in this country we must increase the quantities of power and heat that are raised. This will require the expenditure of more coal than we are using to-day if the coal is used with the same efficiency. Yet the plain fact is that the output from the mines is very much less than it was before the war and still less than it was in 1913, so that we are only able to make our available coal supplies cover our basic requirements by the fact that we have ceased to export coal and that we have ceased to a very large extent to use coal for shipping.

Past Wastage

It is interesting to observe that in the changes that have taken place in the coal position over the last 150 years may be seen the workings of our economic system. It is arguable that the century or so that ended with the start of the first German war was the business man's century. It was a period in which the use of science and the amount of scientific knowledge possessed by those engaged in industry were alike very much less than they became in the succeeding years. This does not mean that our ancestors were unscientific but simply that the whole structure of business was dominated by the business and commercial men. During this time the coal mines, for example, were owned by a multitude of individual companies, small and large, each of whom exploited—and there is no other word so appropriate—their own particular holdings without reference to what their neighbours were doing and in such a way that they secured the maximum profit in their own personal lifetimes. The result was a very great waste of coal in the processes of mining and the development of mines with such lack of system or orderly plan that when the Reid Committee reported a year or two ago they had to propose regionalisation of the coalfields followed by a vastly expensive plan of complete underground reorganisation extending over whole areas. During the same period the individual user of coal had been wasteful in the extreme. So long as he secured whatever

steam, power or heat he required he cared very little as to how much fuel was burnt in the process. He excused his complete lack of knowledge of fuel technology by the aphorism that "British industrial prosperity was based on cheap coal."

Not Inexhaustible

During this time there were many who lifted their voices to point out that our coal supplies were not inexhaustible. They were voices crying in the wilderness and they were not heeded by those who alone could have put matters to rights. It was the day of the business man and the business man thought only in terms of money and cared little what happened after he had finished with the coal. There is a Spanish proverb which goes: "Take what you will," said God, "take what you will—and pay for it." This is exactly what we have done with coal in this country over the past 150 years. And now has come the time to pay for it. It is becoming apparent that our coal reserves will be virtually exhausted in another 200 years or even less. It has become apparent that the price of coal has soared suddenly over a very few years and that it will never return to anything like even pre-1939 figures, and that it may never fall appreciably in price. In 1913 the cost of mining coal was 9s. 5½d. a ton; in 1938 it was 16s.; in 1945 it was 38s.; it is still rising.

One unfortunate result of this sudden rise in price is that it has not been paralleled in other countries to the same extent. A year ago Mr. G. H. Latham pointed out that the United States steelworks were receiving coal at a cost which was 20s. a ton less than that at which it was delivered to steelworks in this country, with the result that £2 a ton was given to American steel producers in world markets. That is an important and serious consideration.

During the year under review measures have been taken to correct the difficulties into which the prodigality of our ancestors has led us. It was inevitable that since coal is the greatest national asset which we have it should become the property of the nation and moreover that the nation should undertake to work the coal mines in an orderly plan. Whether we like nationalisation or not there is no doubt that a strong case can be made out on technical grounds for a complete change of method in coal mining. That change of method has been instituted by the present Government through the setting up of the National Coal Board which took office on January 1, 1947. Whether the National Coal Board will succeed where private individual ownership has failed is a matter upon

which the future alone can give the answer. In fact the National Coal Board has come 100 years too late.

Value of Economies

If it is necessary to correct the mistakes of the past in the production of coal, it is equally necessary to correct mistakes in the utilisation of coal. The fuel efficiency campaign of the Ministry of Fuel and Power has been continued during 1946 even though the war has come to an end so far as the firing of bullets is concerned. The Fuel Efficiency Committee is likely to continue in being because its work has been proved valuable. It is probable that the amount of coal now being saved directly by the combined efforts of the Committee, of voluntary helpers all over the country, and of the Fuel Efficiency Branch of the Ministry is of the order of ten million tons a year. That is a very considerable quantity, and reflects great credit upon everyone concerned. It is, however, probably not by any means as much as could be saved if we set about it in a comprehensive and organised manner. One of the features of the past year has been a paper by Mr. Oliver Lyle entitled "Inefficiency," in which he has examined most of the major uses of coal in this country and has come to conclusions upon the efficiency with which coal is used and the efficiency with which it might be used. Here in the form of a summarised table is an account of the savings that appear to be possible if Mr. Lyle's thesis is correct:—

	Coal saved a year—tons
Better generation of power in industry	
Improvement in machines, and some district heating from power stations ...	21,000,000
Electrification of the railways ...	9,000,000
Improved efficiency of power utilisation at collieries ...	5,500,000
Improved efficiency of power utilisation at iron and steel works ...	2,000,000
	37,500,000
Heating	
Better use of domestic coal ...	23,000,000
Non-industrial heating ...	1,000,000
Industrial heating ...	11,700,000
Better use of carbonised products ...	8,200,000
	44,900,000
	81,400,000

This amounts to something like 45 per cent of the total amount of coal now used in this country. It is possible that Mr. Lyle's figures of saving may be over-optimistic. Almost inevitably they will be so because we shall never reach perfection. But no serious criticism has been made of them and it is evident that by organising ourselves to use our fuel resources to better advantage we could make do with at most two-thirds of the quantity of coal that we now use. That

would be a very valuable addition to our coal reserves and would provide an important saving in the cost of production of goods of all kinds.

All these problems are entirely technical. The formation of the Ministry of Fuel and Power has for the first time enabled our largest industry to be dealt with by purely technical methods. It seems probable, therefore, that we are coming into a period, which will last at least as long as our coal reserves, in which fuel policy will be based upon technical considerations. This generation has, in the writer's opinion, seen the century of the business man give way to the coming century of the technical man. That constitutes the end of an important chapter in our industrial history, but an equally, or even more important chapter is now being written.

Immediate Problems

Coming to immediate problems, however, it will be common knowledge that during the year our coal stocks have become smaller than they have ever been within living memory. Taking official figures based upon "coal years," the coal year starting on May 1 each year, the following is roughly the position.

	1940/1	1941/2	1942/3	1943/4	1944/5	1945/6
(million of tons)						
Production						
Mined coal	212.8	206.1	201.6	188.9	182.5	173.0
Open cast coal	—	—	1.8	4.1	7.8	9.8
Total ...	212.8	206.1	203.4	193.0	190.3	182.8
Decrease in stocks						
Collieries ...	+0.6	-0.6	-0.2	-0.2	-0.2	-0.7
Distributed stocks ...	+3.0	+0.5	+4.4	-4.5	-2.5	-3.3
	+3.6	-0.1	+4.2	-4.7	-2.7	-4.0
Consumption						
Home ...	190.6	195.5	189.4	186.3	184.6	175.5
Overseas and bunkers ...	18.6	10.7	9.8	11.4	8.4	11.3
	209.2	206.2	199.2	197.7	193.0	186.8

The stocks of coal expressed in thousands of tons were as follows:

	Stocks (1,000 tons):—	Distributed	At Collieries	Total
End of Dec. 1940 ...	17,618	4,497	22,115	
—do— 1945 ...	12,442	2,948	15,490	
June ... 1946 ...	8,275	1,852	10,127	
July ... 1946 ...	6,800	2,100	8,900	

In July last, Mr. Shinwell, in Parliament, estimated that the total production for the succeeding 12 months would be 185.9 million tons, whereas the total consumption was estimated to be 196.2 million tons. Thus there would be a deficit of 10.3 million tons, and since the stocks held were only 8.9 million tons there would be more coal required than we had any possibility of obtaining. The immediate problem is there-

fore (a) to increase production and (b) to produce consumption per unit of output. Something has already been done towards increasing production. In 1938-1939 the tons of coal produced per man-shift were 1.14 and in the first nine months of 1945 this figure had dropped to 0.99. Since then it has been rising appreciably. The figure for the first six months of 1946 was 1.02 tons per man-shift. In October of 1946 it had been increased to 1.05 tons and in November to 1.06 tons.

The mines, therefore, are doing their part. It rests with industry to assist and to do its part by using coal more efficiently. We do not want coal to be saved by a serious reduction of industrial output. Already production has been drastically reduced in some industries owing to fuel shortage. Sir Stafford Cripps, at the Ministry of Fuel Conference, said: "If at this stage in our reconversion and of building up our exports we suffer from an interruption in industry due to fuel and power shortages, it will be the gravest thing for our future national industrial prospects. . . . There is only one way in which we can possibly meet the ever-growing demand for production of every kind, and that is by increasing efficiency in production."

Stretching Our Reserves

As one method of stretching our coal reserves the Government has completely reversed previous policy as regards fuel oil. During the period 1920-39 when every endeavour was made to increase the coal output from British mines by disposing of more coal, any competitor to coal was met with the strongest possible competition. This competition was not confined to technical argument, but was carried into the political sphere. So far as concerns coal and oil the coal industry won, and in 1933 a tax of 1d. a gallon was imposed on all fuel oil. This tax was undoubtedly effective in preventing the further importation of additional quantities of fuel oil. To-day we have reached the stage at which the coal industry cannot produce enough coal to satisfy our requirements. At the same time the oil industry does not urgently require to get rid of fuel oil, because there is an adequate world market for it. The time has therefore come when both industries can take a balanced view of the situation and consider it afresh. In the writer's view, as expressed in a talk to the Fuel Luncheon Club in November last, the right policy to-day would be to consider the needs of the user as paramount. There are uses for which oil fuel is claimed to give economic results superior to coal at the prices now ruling. A great many of these uses depend upon the high radiating power of an oil flame so that oil is particularly useful where rapid heating is required and particularly

where the need for rapid heating is combined with the need for very high temperature. Our future policy as regards fuel oil should be that the competition between oil and coal should be removed from the sphere of politics and of purely commercial competition and should be based upon technical and economic factors alone. The coal and oil industries should consult together in order to determine for which uses oil is advantageous and for which uses it should be barred. But at the same time there must be no cessation of technical effort on the part of both industries so that those engaged in the utilisation of both fuels should continue to strive to improve the efficiency of use even for those purposes for which that particular fuel is at the moment inferior to its competitor.

Education in Technology

Much of the improvement that is necessary in fuel utilisation depends upon education. It is one of the achievements of the Ministry of Fuel and Power that, through the initial driving force of the Fuel Efficiency Committee, education in fuel technology has been brought to a pitch never before attained in this country. It all started in a humble and tentative way when, in 1942, courses of from five to twelve lectures were instituted up and down the country given by practising fuel technologists to engineers, executives, business heads, stokers and indeed everyone who had anything to do with the handling of fuel. These courses were continued in succeeding years and were supplemented by "brains trust" discussions, discussion groups, special lectures, conferences and refresher courses at universities and technical institutions. More than 25,000 people have attended these courses and there is no doubt that they have done a very great deal to awaken the nation to a sense of what can be done in using fuel to better advantage.

This, however, is only the beginning. The Ministry of Fuel and Power is collaborating with the Institute of Fuel and has set up Joint Regional Committees all over the country, upon which the Institution of Gas Engineers is also represented. Courses are being instituted at technical colleges whereby a man knowing nothing whatever of the subject can enter at the bottom and, if he has the ability and the desire so to do, can ascend rung by rung, year by year until ultimately it will be possible for him to obtain Corporate Membership of the Institute of Fuel. Naturally anyone may step on this ladder at any level which his attainments permit. The educational ladder comprises a first year devoted to giving the most elementary instruction to the unlearned and ending in an examination of the most simple type possible. Those who pass this examination are then examined on the fring

floor by a Ministry engineer or stoker demonstrator and, if successful, are given a certificate of proficiency by the Ministry. Two more years' attendance at a course on boiler house practice bring to the successful candidate who can pass the examination a certificate from the City and Guilds. Another two years in combustion engineering should give to the student quite a considerable knowledge of the principles of fuel technology, and with the ancillary subjects which he can take simultaneously he should be in a position to start working for the first part of the Associate Membership of the examination of the Institute of Fuel.

Encouraging Students

It is sad to record that at the moment the number of candidates for the City and Guilds courses is very small, and a good deal of spade work will have to be done to obtain sufficient numbers of people to take this course. If, as is hoped, employers will back the Ministry by recognising that those who pass the examinations should be recommended for promotion when vacancies occur and in any event should be given increased wages on account of their proficiency, the necessary numbers of students should come forward without any hesitation.

The year has seen further developments of the gas turbine and it seems very probable that this form of prime mover is about to take its place among the standard machines used for the production of power. Machines of considerable size are in operation in Switzerland and in America, and are being developed in other parts of Europe. At present the gas turbine uses oil fuel, but designs have been drawn up whereby it can be fired with coal and, of course, with coal gas.

District heating has been loudly acclaimed in many quarters during the past year as the ideal method of providing the heat for new housing estates and for towns which are being largely rebuilt. It is doubtful whether the claims for district heating can be substantiated. If district heating were applied by using the heat now dissipated from power stations it would be fully justified. It happens, however, that the heat dissipated from a condensing power station is too low in temperature to be used for this purpose. Back-pressure turbines would have to be installed, and this would mean complete re-equipping of power stations with, in addition, boilers of considerably larger capacity.

This use of exhaust steam from power stations may prove practical for completely new stations situated in a populous area, but the electrical industry at the moment shows a marked lack of enthusiasm for tying itself up to district heating schemes. It is demonstrable that a separate district heating station is less efficient than known methods

of using coke and gas. Put in another way, this means that if a given amount of heat at various temperatures is to be applied for domestic purposes, it can be applied with less expenditure of coal in the form of coke and gas (including the fuel expended at the gas works) than in the form of hot water supplied from the central stations.

The chemical utilisation of coal has made some progress, but no details have yet been made public. It was announced earlier in the year that I.C.I. had commenced the building of a large factory for this purpose in the North of England, but it has not been announced in what direction the chemical utilisation of coal is to be conducted. Further experiments have been made during the year on the recovery of ethylene from coke oven gas and upon its use for the production of chemicals. A useful paper on this was presented by Dr. Booth to the Institution of Gas Engineers in June. Those who have investigated the Fischer-Tropsch process in Germany have not found that any great advances have been made in that process during the war. It would seem that the time has come to take stock and to endeavour to discover for what chemicals there is a sufficient demand to warrant consideration of new large-scale production from coal, and for which of all those chemicals this method of production would be economic.

Efficiency the Keystone

There are many other matters which could be touched upon if there were sufficient space available for so doing, but enough has been said to show that the principal need for the immediate future is for the more efficient utilisation of fuel in every form. Perhaps it is in the utilisation of steam that the greatest single immediate advance is possible. New works are being built, new plant is being added to old works. It is very important that the planning of new plant should be such as to make the greatest possible use of the heat which is expended. It almost always pays to buy the best.

The profession of fuel technology has advanced very considerably during the year that has been under review, and perhaps the most striking evidence of that advance has been the granting of a Royal Charter to the Institute of Fuel. During the presidency of Dr. E. W. Smith the Institute rose from a membership of about 1000 to a membership of well over 2500. Its reputation stands very high indeed among the chartered institutions of the country. During the course of the year, Dr. E. W. Smith has handed over the presidency to Professor C. H. Lander. There is no reason to doubt that the Institute of Fuel will proceed from strength to strength, a measure of the increased importance of fuel technology in the industrial life of the country.

PARLIAMENT AND THE CHEMICAL INDUSTRY IN 1946

by OUR LEGAL CORRESPONDENT

THE first session of the present Parliament established a record by the number of Acts which it passed. No fewer than 83 became law. While none of them was directly or mainly concerned with the chemical industry, it is not surprising that there are several which affect it closely.

The most vital measure was one of the first to be passed—the Supplies and Services (Transitional Provisions) Act. This can best be described as a peace-time Emergency Powers Act. The war-time Act was due to expire and this new Act extends many of the powers in the war-time Act for a further five years for peace-time purposes. As a result the control of industry is still as strict, but it is directed towards a different end.

The King has power to apply Regulations by Order in Council "for the purpose of so maintaining, controlling and regulating supplies and services as (a) to secure a sufficiency of those essential to the wellbeing of the community or their equitable distribution or their availability at fair prices; or (b) to facilitate the demobilisation and resettlement of persons and to secure orderly disposal of surplus material; or (c) to facilitate the readjustment of industry and commerce to the requirements of the community in times of peace."

Minister's Powers

Part IV of the Defence Regulations dealt with supplies and services. Any Regulation in Part IV may be kept in force for these new purposes, even though its original purpose of "maintaining supplies and services essential to the life of the community" has expired. It may be amended or replaced by a new Regulation and further Regulations may be added. By a pre-war Act the Minister of Supply had power to acquire, produce or dispose of supplies which he was satisfied that it was necessary or expedient to maintain, control or regulate for war purposes. This power is now extended to cover the peace-time purposes set out. Further, Regulations may be issued setting up price controls and varying the Goods and Services (Price Control) Acts.

All Regulations issued under this Act must lie before Parliament for 40 days. They become law unless a prayer to the King to annul them is passed within that time.

Full use has been made of these powers. General Regulations are in force controlling industry as a whole; imposing special controls on essential production undertakings,

providing for books to be kept in the form required and to be inspected; establishing standard specifications and price control for manufacturer, wholesaler and retailer over a wide field; establishing a control by licensing of industrial building; providing for the disposal of essential reserves; providing for the taking over of, or appointment of directors in, certain businesses in certain cases. Further Orders have been issued under these regulations dealing in detail with specific commodities.

Social Security

The year has seen the passage of three major measures, the National Health Service Act, the National Insurance Act, and the National Insurance (Industrial Injuries) Act. Thus, apart from the reform of the Poor Law, a bill on which is promised for next session, the Beveridge Plan has become law. It is not expected that the new schemes will be fully in operation before 1948.

The employer is now relieved from the liability for Workmen's Compensation. This becomes a matter for State insurance and has been welcomed by both sides of industry alike. But the new all-inclusive National Insurance will set a problem to those employers with group insurance schemes. Simply to let the employee pay both contributions and accept both benefits may not be the best solution, especially where wages are low. The double contribution may impose an unduly heavy burden on the weekly budget and unless the group insurance is adjusted the worker will tend to drop out of it. In most cases this can be settled by negotiation with the insurance company concerned, but there will be a further complication in those concerns where the group insurance scheme has statutory force; an amending Act will be necessary before it can be adjusted.

In all three Acts there is emphasis on research to prevent accidents and sickness and to speed up rehabilitation. This will be welcomed for every reason by employers and workers alike.

An emergency measure arising out of the war was the new Patents and Designs Act. It provides protection for those whose inventions have been used, either in this country or abroad, for the common struggle during the war. The inventor will be given priority in registering. If the invention has been discovered and worked secretly priority is given to the person who discovered it first. Provision is also made as to the pub-

lication of inventions made in Germany or Japan between September, 1938, and the end of 1945.

Atomic Energy

A new field of chemical research is closed to private enterprise by the Atomic Energy Act. The responsibility for promoting the control and development of atomic energy is laid upon the Minister of Supply and he is given the necessary authority and funds to engage in research and production. Atomic energy is defined as "the energy released from atomic nuclei as a result of any process, including the fission process, but not energy released in any process of natural transmutation or radio-active decay." The Minister may require from any firm full particulars of their plant, contracts, stock of minerals and of "prescribed substances," which are uranium, thorium, plutonium, neptunium or any of their compounds; the Minister may add other substances to this list by order.

The Minister has power to acquire land to be worked for minerals and to acquire compulsorily prescribed substances, minerals, plant, contracts and information, subject to compensation. He has power to prohibit, except under licence, the working of specified minerals or the acquisition, production, treatment, possession, use, disposal, export or import of specified minerals, prescribed substances or atomic energy plant. Unauthorised disclosure of information is to be a punishable offence. Patenting of inventions relating to atomic energy is also closely controlled. In short, no work of any kind may be done in connection with atomic energy, except under licence from the Minister of Supply.

Other questions will be decided by an insurance officer. An appeal lies from his decision to the local appeal tribunal, which consists of a chairman appointed by the Minister and an equal number of employers' and workers' representatives. From them an appeal lies to the Industrial Injuries Commissioner, who is to be a barrister of not less than ten years' standing. His decision can be appealed against on grounds of law only and the matter will then be finally determined by the High Court.

The National Insurance (Industrial Injuries) Act 1946, mentioned briefly in an earlier paragraph, is one of the major reforms passed by Parliament in an unparalleled year of legislation. It will come into operation on the "appointed day" fixed by the Minister of National Insurance. The broad outlines of the measure had already been agreed by the Coalition Government.

The whole basis of compensation for the injured workman has been altered. The Workmen's Compensation Acts represented an obligation placed on the employer to make certain payments to employees injured

in the course of their work. The machinery of the state stepped in to do equity between two classes of citizens. Under the new Act it is the state which is to be the insurer. Both parties pay contributions, as they already do for Health and Unemployment Insurance, and in return the State provides benefits far more extensive and generous than those given by the Workmen's Compensation Acts.

The Industrial Injuries Act gives expression to the new attitude towards industrial injury, which developed so rapidly during the war, when every man-hour was precious. The injured worker is no longer simply an unfortunate to be assisted by the benevolence of the legislature. His working capacity is a loss to the community, which must be restored as soon as possible. The Minister will be spending his Fund on rehabilitation and research, as well as benefit. It will be his function not merely to compensate injury and disease, but also to prevent it.

One of the flaws in the Workmen's Compensation Acts was that compensation was based on loss of earning capacity, so that the worker was discouraged from returning to work as soon as possible. The new Act gives compensation for permanent injury on the same basis as war pensions, that is to say a pension is awarded, which is assessed by comparing the claimant with the average healthy person, and is then paid whether the claimant returns to work or not.

Lawyers Lose a Gold Mine

It is notorious that the Workmen's Compensation Acts have provided a gold mine for the lawyers. The phrase at the opening of the 1925 Act "personal injury by accident arising out of and in the course of employment" has probably been more fruitful of litigation than any other phrase on the Statute books. It was inevitable that there should be a great deal of litigation, because so many people were affected. More and more Acts became a battle ground between the insurance companies of the employers and the trade unions. Not that the worker could complain that his employers were insured; then at least he had some assurance that he would continue to draw his compensation if his employers went bankrupt.

All disputed cases went to the County Court. Often one would see a Judge with no medical training called upon to decide a purely medical point, in which eminent specialists called by each side had contradicted one another. This expensive system is superseded in the new Act, which sets up medical tribunals to deal with medical questions and provides special tribunals to deal with other questions, with an appeal to the High Court on questions of law only. No doubt there will still be plenty of litigation;

but the courts will be restricted to their proper field.

The Act covers all persons "in employment in Great Britain under any contract of service, whether written or oral, and whether express or implied." The upper income limit of £420 per year in the Workmen's Compensation Acts is swept away. A scale of weekly payments is laid down, the maximum being 4d. per week from the employer and 4d. from the employee in the case of an adult worker. Contributions are paid into the Industrial Injuries Fund and the Treasury adds a sum equal to one-fifth of the aggregate of workers' and employers' contributions.

There are provisions with regard to weekly payments, similar to the already familiar provisions for National Health and Unemployment Insurance. In due course the contribution will be included in the one insurance stamp.

Administration of the Fund

The fund will be administered by the Minister of National Insurance. He is responsible for the employment of staff, including those in judicial positions who will decide claims which arise. The Government Actuary is to report on the finances and working of the Fund every year for the first five years. An Industrial Injuries Advisory Council, drawn from a wide field, will assist the Minister.

The power to expend money on research extends to any research into the causes and incidence of and methods of prevention of accidents, injuries and diseases against which persons are insured. The Minister can also make arrangements with the Minister of Labour to allow persons receiving disablement benefit to take full advantage of vocational training courses, industrial rehabilitation and similar courses and contribute towards the expense out of the fund. He can also provide artificial limbs free or at cheap rates.

The Minister will appoint inspectors who have the right of entry to any place in which they have reasonable grounds for supposing that insured persons are employed, or an injury or disease has been or may have been contracted, which has given, or may give, rise to a claim for benefit, except a private house not used for trade or business. He has wide powers to inspect the premises and to question persons there in connection with any matter arising under the Act. Employers and workers must furnish him with all the information and documents he may require, subject to a penalty of a fine.

Obligations are also laid on workers with regard to reporting accidents and on employers to supply all necessary information in relation to accidents.

The medical tribunals mentioned above are to decide disablement questions, whether a

claimant is disabled and how badly. Questions of temporary disablement up to three months may be referred to a single doctor. Usually cases will be referred in the first instance to a medical board of two doctors. There will be a right of appeal to a medical appeal tribunal of three doctors. The boards and tribunals will have power to review their decisions, but this will not normally be done in less than five years, or less than six months in the case of a provisional assessment.

Benefits Provided

The right of benefit still depends on injury by accident arising out of and in the course of employment; this has now been extended to cover accidents happening while meeting an emergency and accidents while travelling in an employer's transport. The claim that all accidents sustained while travelling to and from work should be compensated was rejected. Previously the worker was covered only when his contract obliged him to use the employer's transport and not when he chose to do so. Industrial diseases are covered in much the same way as under the Workmen's Compensation Acts.

The first 26 weeks of disablement are covered by injury benefit. The rate is 45s. per week or 7s. 6d. per day. The rate is reduced for juveniles. No benefit is payable for the first three days, unless the injury lasted at least twelve days. A married man gets an additional 16s. per week for his wife, and 7s. 6d. for his first child. If, after 26 weeks, the injured person is suffering from a loss of physical or mental faculty, which is either permanent and amounts to a disability of 1 per cent or is substantial and amounts to not less than 20 per cent, he can claim disablement benefit. The disability is assessed by comparing the claimant with an average person of his age and sex; only the disability which is attributable to the accident or disease is taken into account. A provisional assessment may be made where the claimant's condition is not stable.

Where the assessment is less than 20 per cent, the claimant will receive a lump sum varying according to the severity of the injury, and its probable duration, the maximum being £150. If it is 20 per cent or more he will receive a disablement pension. This is 9s. for 20 per cent disability, with an additional 4s. 6d. for each 10 per cent disability, up to 45s. for 100 per cent.

A claimant who is unemployable, that is, unlikely to earn more than £52 in a year, can get an unemployability allowance of 20s. per week. A 100 per cent pensioner who needs constant attendance can claim a constant attendance allowance of £1 per week, or, in exceptional cases, £2. A pensioner receiving approved in-patient treatment in hospital will have his pension made up to the 100 per cent rate during the treatment.

The case of the man who is not 100 per cent disabled, but is quite unable to do his previous job, is catered for by provision for an increase of 11s. 3d. in the pension, provided that his total pension does not exceed the 100 per cent rate.

A pensioner will also draw dependent's allowance of 7s. 6d. for his first child; 16s. is payable for his wife if he is receiving approved treatment in hospital or unemployment allowance. Thus, a married man with one child who is 100 per cent disabled and unemployable will receive 45s. plus 20s. plus 16s. plus 7s. 6d., making £4 8s. 6d. a week.

Death benefit is also provided. Under Workmen's Compensation a widow received no pension but only a lump sum varying from £400-£700, according to the deceased's earnings and the number of dependent children. This meagre provision has been

swept away and the widow will now draw a weekly pension. For 13 weeks after death the pension will be 36s. per week. Then it will be reduced to 30s., if she is over 50 or has a dependent child, or is permanently incapable of self support. Otherwise it will be reduced to 20s. An additional 7s. 6d. is payable for the first child. The pension ceases on remarriage and the widow then receives a gratuity equal to fifty-two weeks' pension.

The new Act also covers a wide field of dependents, who previously had no claim. The dependent widower, parents who were being maintained to a substantial extent by the deceased and relatives who were being wholly or substantially maintained, and women having one of the deceased's children in their care are all entitled to make a claim.

German Chemical Output

British Manufacturers' Concern

THE concern that is felt in the British chemical industry regarding the war potential that will ultimately be available to Germany, if she is allowed to retain her productive capacity in chemicals to the extent now planned, is alluded to in the annual report of the Chemical and Allied Trades Section of the Manchester Chamber of Commerce.

The chairman, Mr. Forrest Hewit, states in the report: Discussions are taking place concerning productive capacity which it is now planned to leave in German hands. It is understood at the moment that in relation to 1936 output, 80 per cent of pharmaceutical production, 40 per cent of heavy chemical production, and 70 per cent of other chemical production will be retained. It is realised that Germany must eventually build up a sound economy, but some concern has been expressed at the war potential which will be available if such percentages are ultimately permitted.

Mr. Hewit opened the report by stating: 1946 may be recorded as a year of sustained progress in the reconversion period of the chemical industry, despite the many problems which have arisen to complicate the task. During the year it has been the policy of the industry to give priority to the needs of manufacturers in this country in order that the export drive shall not be impaired. Notwithstanding these demands, however, it has been possible almost to double export figures in comparison with 1945 returns. In relation to the 1938 figures the volume of export has increased by no less than 60 per cent, a commendable achievement towards the objective of 75 per cent set by the President of the Board of Trade.

During the first ten months of the year the value of chemicals, drugs, dyes, and colours exported totalled £55.0 millions, compared with £30.8 millions in 1945, and £18.0 millions in 1938. In considering overseas trade it should be remembered, however, that Germany, our principal pre-war competitor, is temporarily out of the field. Further effort will be required when exports from this source are resumed.

Difficulties besetting the expansion of the industry include shortages of plant, buildings, and equipment required for replacement and extension; obstacles have also been encountered in obtaining trained technical personnel and an adequate amount of labour. In connection with equipment it was hoped that valuable assistance would be forthcoming from the importation of German chemical plant as part of the war reparation, but expectations in this direction have so far not been realised.

After referring to Germany's productive capacity, Mr. Hewit went on: As a defeated nation Germany has had to submit to an investigation of her plants and processes, and many excellent reports have been published by teams of scientists, through which much time and research effort will be saved by British firms, but these facilities are available to foreign firms and no exclusive advantage will accrue to the chemical industry in this country.

The mining and metal industry of Austria has, during the last year, increased from month to month. The October production amounted to 10,227 tons of coal, 203,283 tons of lignite, 14,000 tons of magnesite, 58,658 tons of iron ore and 15,000 tons of steel.

News Events of 1946

JANUARY

Chemical and allied sciences and the chemical industry were well represented in the New Year Honours List.

Mr. H. W. Cremer was appointed a joint honorary secretary of the Society of Chemical Industry.

The first post-war exhibition of scientific instruments and apparatus was opened at the Imperial College of Science and Technology in London.

Mr. D. N. Lowe was appointed secretary of the British Association for the Advancement of Science in succession to Dr. O. J. R. Howarth, who retired.

The American Chemical Society's Priestley Medal was awarded to Professor I. M. Heilbron, F.R.S.

The first batch of German scientists and technicians arrived to work in this country.

A successful inaugural year was reported at the first annual meeting in Manchester of the North-Western branch of the Institution of Chemical Engineers.

By retirement, I.C.I. lost two well-known personalities in Dr. Roland E. Slade, Research Controller, and Lt.-Col. G. P. Pollitt, D.S.O., M.Sc., Ph.D., one of the original directors and mainspring of the inspiration that founded the Billingham works.

Awards totalling £10,000 were made from the Harmsworth Trust Fund to three leading scientists who discovered and developed penicillin: Sir Alexander Fleming; Sir Howard Florey; and Dr. Boris Chain

Production of penicillin at the Speke factory, Liverpool, reached 80,000 mega units in the month—about one eighth of the total United States output.

I.C.I. and Tatas announced an agreement to establish in India an industry for manufacturing the entire range of dyestuffs for the Indian market.

FEBRUARY

The formula of Paludrine, the revolutionary anti-malaria drug, discovered by I.C.I. scientists, was disclosed.

The formation was announced of a Joint

Committee on Metallurgical Education by the five leading national metallurgical institutes.

Full-scale activity was resumed by the Copper Development Association.

Under the auspices of the Institute of Physics, an Industrial Spectroscopic Group was formed.

Mr. G. F. Laycock was elected president of the Institution of Mining and Metallurgy, in succession to the late Lt.-Col. Edgar Pam.

The Prime Minister in Parliament endorsed the policy of directing scientific research to the substitution of home-produced for imported raw materials.



Dr. Roland E. Slade

To make arrangements for the Chemical Society's centenary celebrations in 1947, the council set up an executive committee.

The United States Board for the Co-ordination of Malarial Studies announced that compounds considered superior to quinacrine (atabrine) had been developed.

MARCH

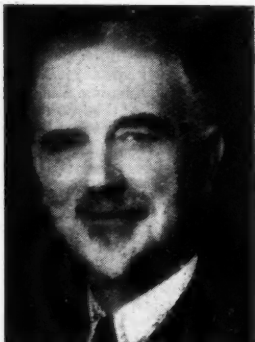
The world's largest uranium deposit was reported to have been found near Stanthorpe, Queensland.

Dr. John Brittain, Director of Research, Explosives Projectiles, was killed in an aircraft crash.

First of its kind in a British university,

the appointment was announced of Dr. Leslie Aitchison to the newly-established Chair of Industrial Metallurgy at Birmingham University.

The first post-war industrial exhibition in the London area took place at the Renault Works, Acton, chemical concerns being among those participating.



Dr. Wallace P. Cohoe

The Messel Medal for 1946 was awarded to Dr. Wallace P. Cohoe, a past-president of the Society of Chemical Industry and past president of the American and Canadian sections.

The Mond Nickel Company offered £50,000 to the five metallurgical institutes to provide for additional special training of metallurgical students.

A gift of nearly £137,000 from constituent associations and members of the British Non-Ferrous Metals Federation enabled Birmingham University to proceed with plans for the development of its metallurgical department.

At the 68th annual meeting of the Royal Institute of Chemistry Dr. Gerald Roche Lynch was elected president in succession to Professor Alexander Findlay.

A White Paper was issued giving the text of the agreement between the British and United States Governments on the principles applying to the exchange of information relating to the synthesis of penicillin.

Steel production in Great Britain during the month was at an annual rate of 13,295,000 tons—highest ever achieved in peace-time.

After long association with the chemical industry in an administrative capacity, Mr. A. S. Chamberlain, B.Sc., retired from the board of I.C.I., Ltd. (General Chemicals Division).

APRIL

The question of the industrial development of atomic energy was raised in the House of Commons.

A two-day conference on "Industry and Research" was held in London under the auspices of the Federation of British Industries.

Development of a new type of synthetic resin was announced by the Plastic Division of I.C.I.

Mr. C. M. Whittaker, B.Sc., succeeded Dr. C. J. T. Cronshaw, as president of the Society of Dyers and Colourists.

The death took place of Mr. Harold Wright, chief metallurgist to Dorman, Long and Co. and an honoured figure in the metallurgical world.

A war-time group of light metal manufacturers collaborated to form a development organisation known as "Alar."



The Late Mr. Harold Wright

Transfer of its entire laboratory chemical section to the former British Power Boat Company's factory at Poole, allocated to it by the Board of Trade, was proposed by British Drug Houses, Ltd.

The necessity for increased supply of raw materials to prevent "widespread chaos" in the industry was emphasised by the president of the National Paint Federation, Mr. C. Owen Morley.

Courtaulds, Ltd., gave £60,000 to Leeds University for the establishment of a rayon division in the department of textile industries.

The Iron and Steel Institute awarded the Bessemer Gold Medal for 1946 to Mr. J. S. Hollings, of Guest Keen Baldwins Iron and Steel Co., Ltd.



Sir Archibald Fleming

The first recorded death in England and the second only in the world from DDT insecticide was that of a farm labourer in Lancashire, who died from the toxic effects of drinking mushroom-fly DDT concentrated emulsion.

Professor W. N. Haworth was appointed chairman of the Chemistry Research Board of the Department of Scientific and Industrial Research.

MAY

The Minister of Supply announced a Government decision to make penicillin available to the public against a doctor's prescription.

The iron and steel industry's seven-and-a-half years' plan for its own re-organisation and modernisation was published in a Government White Paper.

The Soviet Scientific Research Institute of Metallurgy invented a new alloy, described as of great magnetic strength and called "Magniko."

A provisional long term programme of capital expenditure covering the next eight years, amounting in all to over £40,000,000 was announced by the chairman, Lord McGowan, at the annual meeting of I.C.I., Ltd.

A start was made on the erection of the I.C.I. factory at Billingham for the manufacture of nylon polymer.

For their services in the discovery and development of penicillin, Professor Sir Alexander Fleming, F.R.S., F.R.C.S., F.R.C.P., and Professor Sir Howard Florey, F.R.S., M.A., B.Sc., Ph.D., were jointly awarded the Albert Gold Medal of the Royal Society of Arts.

Warning that, unless coal supplies improved, further cuts might be expected in our export of essential chemicals was given by Lord McGowan, chairman, at the annual meeting of I.C.I., Ltd.

An Atomic Scientists' Association was formed in London, and issued its first memorandum.

JUNE

At the 27th annual general meeting of the Chemical Engineering Group of the Society of Chemical Industry, Mr. M. B. Donald was re-elected chairman.

The German process of making butter from paraffin produced from coal was illustrated in photographs published by THE CHEMICAL AGE.



Sir Howard Florey

Lieutenant-Colonel F. J. Griffin took up his duties as general secretary of the Society of Chemical Industry.

The first woman to become an officer of the Pharmaceutical Society of Great Britain, Mrs. J. K. Irvine was elected vice-president.

H.M. the King opened the Empire Scientific Conference in London, convened and organised by the Royal Society.

Well-known personalities in the chemical and allied sciences figured in the Birthday Honours list.

A survey undertaken by the United States Department of Commerce revealed the seriousness of the world shortage of fertilisers.

Associated with the chemical industry since 1897, Mr. Dudley Christopherson, sales director of Albright and Wilson, Ltd., retired.

JULY

Manchester College of Technology received a gift of £60,000 from Courtaulds, Ltd., to provide re-equipment for teaching and research in rayon technology.



Dr. L. H. Lampitt

Production details of "Teflon," the tetrafluoroethylene polymer developed for war purposes by Du Pont's, were published.

A party of Russian scientists visited England.

The silver jubilee of the discovery of insulin was marked by a gathering of the Diabetic Association at the Royal Institution.

Dr. L. H. Lampitt was, at the 65th annual meeting, elected president of the Society of Chemical Industry, succeeding Dr. E. K. Rideal, F.R.I.C., F.R.S.

Chairman of the American section of the Society of Chemical Industry in 1944-5, Dr. Foster D. Snell was elected president of the American Institute of Chemists.

Dr. D. F. Twiss, D.Sc., F.R.I.C., retired after a distinguished career, including 32 years as chief chemist to the Dunlop organisation.

AUGUST

The Swiss chemical and pharmaceutical concern, F. Hoffman-La Roche and Co., celebrated the fiftieth anniversary of its foundation.

The Mineral Development Committee, to inquire into the metalliferous and other mineral resources of this country, was set up by the Minister of Fuel.

Six corporations and five individuals were charged at Denver, Colorado, with conspiring to fix prices and monopolise the United States vanadium industry, in contravention of the anti-trust laws.

Details of the process developed in the United States for the commercial production of phthalic anhydride from petroleum ortho-xylene instead of from naphthalene were published.

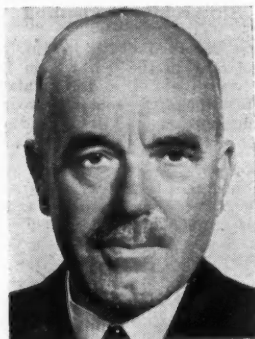
SEPTEMBER

Names of first members of the board set up to supervise the development and reconstruction of the iron and steel industry were announced by the Ministry of Supply.

A number of German metallurgical enterprises resumed operations.

The Scientific Society of Zurich, Switzerland, celebrated its bicentenary.

The present and prospective position of plastics was surveyed by Dr. V. E. Yarsley, D.Sc., M.Sc., F.R.I.C., in a paper at the International Technical Congress in Paris.



Dr. D. F. Twiss

A fellowship scheme and two scholarship schemes to advance research, teaching and training in extraction metallurgy were established by the Nuffield Foundation.

The Chemical Industry Medal of America for 1946 was awarded to Dr. W. H. Dow, president and chairman of the Dow Chemical Company and president of the Ethyl-Dow Chemical Company.

The "Britain Can Make It" exhibition was opened by H.M. the King.

Pilot-scale production of streptomycin, it was announced, was to be undertaken by a number of British firms.

Mr. Geoffrey Heyworth, chairman of Lever Bros. and Unilever Ltd., accepted an invitation to become chairman of the Advisory Council for Scientific and Industrial Research, in succession to Lord Riverdale, who retired.



Lord McGowan

OCTOBER

Establishment of a national centre for processing and distributing radium, radon and artificial radio-active substances at Amersham, Bucks., was announced.

Papers of interest to the chemical and allied industries were presented at a conference in London on "Fuel and the Future," under the auspices of the Ministry of Fuel.

The Plastics Group of the Society of Chemical Industry held its first meeting of the session, with an address on recent advances by the chairman, Mr. N. J. L. Megson.

First British firm to install plant for large-scale production of streptomycin, Boots Pure Drug Co., Ltd., made its plans public.

The president of the International Society of Leather Trades Chemists, Professor P. Chambard, was present at the annual meeting of the British Section in Leeds.

An international tin conference was held in London.

Development of a new synthetic fibre, founded on terephthalic acid and ethylene glycol, to be known as "Terylene," was recorded.

The Atomic Energy Bill was passed in the House of Commons.

The possibility of Imperial Chemical Industries manufacturing in China in partnership with the Chinese was referred to by the chairman, Lord McGowan.

A new organic insecticide, Velsicol 1068, was announced by the Hygienic Chemical Company.

NOVEMBER

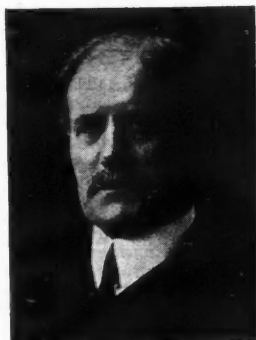
A machine weighing more than 1000 tons and containing a magnet 30 ft. in diameter, for use in nuclear research, was being installed at Birmingham University.

The re-construction of the Skoda Works in Czechoslovakia was reviewed.

One of the few surviving links with Faraday, Professor P. F. Frankland, noted for his research in optical activity and stereochemistry, died, aged 88.

By a majority of 24 votes, members of the British Association of Chemists rejected affiliation with the Trades Union Congress.

Sir Alfred Egerton, M.A., B.Sc., F.R.I.C., F.R.S., Professor of Chemical Technology at the Imperial College of Science, received the Rumford Medal of the Royal Society; and Professor C. K. Ingold, D.Sc., F.R.I.C., F.R.S., Professor of Chemistry at London University, the Davy Medal.



The Late Professor P. F. Frankland

The death took place of Dr. Dorothy Jordan-Lloyd, M.A., D.Sc., F.R.I.C., director of the British Leather Manufacturers' Research Association.

DECEMBER

The synthesis of minute quantities of benzylpenicillin was announced in the United States.

Mr. Norman Sheldon, A.R.C.S., F.R.I.C., was elected president of the British Association of Chemists, in succession to Professor R. G. W. Norrish, D.Sc., F.R.I.C., F.R.S.

The 21st anniversary of the Electrodepositors' Technical Society was celebrated.

The results of the investigation of German technical and scientific discoveries by British and allied experts were seen at an exhibition opened in London.

ORGANIC CHEMICAL INDUSTRY

LORD MCGOWAN [ON BRITAIN'S OPPORTUNITY

THE following article, written by Lord McGowan, chairman of Imperial Chemical Industries, Ltd., appears in the current issue of the *Board of Trade Journal*. An explanatory note states that it should not be regarded as containing official statements of Government policy.

During recent years, science has emerged steadily from the laboratory into direct contact with everyday life. Scientific research has become the life blood of industry; and the efficiency with which industry itself is able to apply the results of this research is a measure of its ability to exist and play a useful part in a fast-developing world.

Contribution to Victory

Throughout the war, British industry was called upon not only to provide the fighting forces with almost all the stores and weapons that they needed, but to carry a large share of the responsibility for ensuring the scientific and technical progress that contributed so much to our victory. The success with which it accomplished both these tasks is recognised throughout the world, and its reputation is correspondingly high. To-day British industry is judged on its war-time record and the world looks to it to supply the consumer goods of peace.

More than almost any other, the chemical industry depends on the direct application of science for its continued progress. During the war, chemical research continued at a high pitch of intensity, making discoveries that maintained our unrivalled war-time record of invention. Many of these were applied directly to the immediate purposes of war; others had to wait until the opportunity for development returned with the coming of peace.

Today the chemical industry covers an enormous range of interests; and the relative importance of the various branches is impossible to assess. There is, however, one branch of rapidly increasing significance, in which Britain has a most powerful stake. That is, the field of organic chemistry.

As an industry, organic chemistry is nearing its centenary. The first coal-tar dyestuff was discovered in Britain in 1856, and the dyestuffs industry that sprang from it has acted as a nucleus for the growth of organic chemistry throughout the industrial world. It presented Britain with a magnificent opportunity which she completely failed to turn to account, and by the end of the century Germany had established herself as the most powerful organic chemical producer. It was not, in fact, until the 1914-1918 war that we in Britain were able to establish our

organic chemical industry on a scale that could compete in the markets of the world.

Between the wars, organic chemistry developed around the growing dyestuffs industry, until by 1939 British dyestuffs were well able to hold their own against competition from Germany and other countries. Most important of all, the British industry had based itself so thoroughly on research that in fundamental discovery and original work its chemists had attained a reputation unsurpassed by those of any other nation.

During the war, the British dyestuffs industry was able to supply the pool of organic chemists essential to the scientific prosecution of the war. It was to dyestuffs laboratories that the nation turned for men to develop the explosives and the plastics, the drugs and disinfectants, and the multitude of other materials needed by the fighting Forces.

Today, we are benefiting from our war-time experience. We enter the era of peace with a powerful research backing and an invaluable manufacturing experience. The world wants British goods, and in helping to supply them the organic chemical industry has a tremendous part to play. Are we ready to accept our magnificent opportunity? Or is our industry failing to respond to the call of progress? The answer is to be found in the record of our war-time achievements.

So far as dyestuffs are concerned, the outbreak of war found the British industry established in the markets of the world. The old myth of German superiority, born of their half-century start, had been exploded. Research continued during the war, though its aims were largely readjusted to meet war-time needs, and many hundreds of new dyestuffs and auxiliary products were developed and new applications devised. Today, the British dyestuffs industry is able to supply a complete range of modern dyestuffs for all purposes.

German Stranglehold

In synthetic medicinals, the Germans had established an extremely powerful hold before the war. Their earlier development of the dyestuffs industry had enabled them to push ahead rapidly into this new and complex field of organic chemistry, and British chemists were finding it difficult to break the stranglehold of the I.G. Many important contributions had been made by British research—for example, in the sulphonamide field—but our drugs industry was not a major supplier of the world market.

The outbreak of war gave the British organic chemical industry an opportunity of

entering the pharmaceutical market on a grand scale. At the same time, however, it was struggling to cope with the tremendous demands that war had placed upon it. Nevertheless, the research backing was there, the organic chemists turned to their dual task and production went ahead. Methods of making established drugs were worked out and manufacture begun. In addition, many new drugs were developed. One example should suffice to illustrate the success with which this job was tackled.

When the Japanese overran Malaya and the East Indies our supplies of quinine were cut off. A critical situation immediately arose, because our armies were already fighting in malarious regions, and their health had to be protected. Our organic chemical industry was called upon to provide the necessary drug, and so undertook the large-scale production of mepacrine, a complex anti-malarial which the Germans had developed before the war.

Within a short time, mepacrine tablets were being manufactured in their hundreds of thousands, and our troops were kept supplied with them throughout the war. Thus stimulated, anti-malarial research in Britain went on to score a signal success on its own account, for in 1945 the discovery of "Paludrine" was announced. This is a more powerful anti-malarial drug than any the world has hitherto seen. After only two or three years, therefore, our research chemists had made a major discovery in a field which had been a German preserve for the last twenty years.

In other medicinal and pharmaceutical industries, the story is the same. Britain has made the most of the opportunities created by Germany's defeat, and is already making major contributions to progress in this new-found field.

Agricultural chemistry also offers a great future to our organic chemist, and impressive advances have already been made in the development not only of insecticides of unparalleled power, but also in the perfection of selective weed killers which have been evolved out of research into plant hormones.

Progress in Plastics

Another most important development in organic chemistry has followed upon the entry of scientific research into the plastics industry. Here again Britain is in the forefront of progress and the achievements of our plastics chemists have brought them world-wide recognition. Outstanding among recent British developments have been "Perspex" and polythene—the first, a transparent material, tough, unsplinterable, and only half the weight of glass. It was used during the war for all transparent surfaces on our bombers and fighters. Now it is undergoing intensive development for a host of peacetime uses ranging from artificial

eyes, surgical splints and lenses to attractive domestic fittings and corrugated sheets for the roof lighting of factories. The second, polythene—an almost indestructible plastic—makes a remarkable insulating material. As such, it played a substantial part during the war in the rapid development of that other triumph of British ingenuity—radar, and its rich promise for a host of peacetime applications is now being explored. The discovery of a new synthetic textile fibre, "Terylene," is the most recent accomplishment of British research in this young but growing branch of organic chemistry.

Confidence in the Future

So, in these few aspects of our organic chemical industry, we can see that Britain is active and alive to the opportunity that is afforded by continued progress and research. We are facing the future with a morale made strong by success. We have the essential foundation of research, we have the industrial experience, and we have the manufacturing resources necessary to bring our discoveries quickly on to the market. Finally, we possess the managerial enthusiasm and drive that spring from sound knowledge and an unbounded confidence in the ability of our employees.

At the moment, Germany, is not to be reckoned with as an industrial exporting nation, but the necessity to reconstruct her economy means that this situation cannot last indefinitely. Whilst it does, however, the markets she once supplied are open to the world. The opportunity is there waiting for us; let us waste no time in making use of it.

Imperial Chemical Industries have already announced expansion schemes for their dyestuffs and allied industries running into many millions of pounds. A large proportion of this expenditure will be on facilities for research, on which they pin their hopes for the future. They are going ahead as quickly as they can with the construction of new and improved chemical plants with which to increase our output, and to begin production of many newly developed products which are now beyond the research stage.

Always at the back of our minds is the conviction that scientific research is the essential prerequisite to success. Only by basing our work fairly and squarely on its foundation can we be sure of progress. Past experience has shown that Britain has men of scientific ability second to none. We are determined that they shall lack for nothing in the facilities essential to their work.

Our post-war plans are at present hampered by the difficulties of the post-war world—shortages of plant, labour and essential services and raw materials. More than almost any other industry, we stand to suffer from shortage of coal, as coal is our primary material.

Personal Notes

MR. H. S. MEERICK has retired from the board of Fisons, Ltd.

MR. H. R. PETERS has been appointed a director of J. M. Steel & Co., Ltd.

LORD MCGOWAN, chairman of L.C.I., Ltd., is on a three months' business tour of South America.

MR. A. E. J. SIMON THOMAS, MR. F. J. TEMPEL and MR. ROGER H. HEYWORTH have been appointed members of the board of Lever Brothers & Unilever, Ltd.

SIR CHARLES BRUCE-GARDNER, who recently resigned his post as chief executive for Industrial Reconversion at the Board of Trade, has been appointed chairman of John Lysaght, Ltd.

SIR VYVYAN BOARD, at his own request, has relinquished his appointment as a director of the Distillers Company with the view to continuing his work in the Government's service.

MR. M. B. DONALD, joint hon. secretary of the Institution of Chemical Engineers and chairman of the Chemical Engineering Group, S.C.I., has had conferred upon him the title of Reader in Chemical Engineering in the University of London, in respect of the post held by him at University College.

LT.-COL. ERNEST BRIGGS, C.B.E., D.S.O., who has been chairman of Lever Bros. (Port Sunlight), Ltd., since 1938, has retired. He was recently presented with a barograph (his own choice), by the Mayor of Bebington, Ald. Henry Wilkinson, from the subscriptions of over 3000 workpeople. He has since joined the board of W. J. Fraser & Co., Ltd., Dagenham, as also has MAJOR F. D. NAPIER-CLAVERING.

MR. G. A. S. NAIRN has been appointed chairman of Lever Brothers (Port Sunlight), Ltd., on the retirement of Lt.-Col. E. Briggs upon reaching the age limit. Mr. Nairn has also been appointed chairman of the committee which has been formed by Lever Brothers & Unilever to co-ordinate its activities in the Merseyside area.

MR. F. K. KIELBERG has resigned from his position as joint managing director of the United Molasses Co., Ltd., but remains chairman. Mr. G. W. SCOTT has been appointed managing director; and the secretary, MR. C. G. ALLOTT, has been appointed a director, Mr. H. T. Schierwater having resigned.

MR. G. IRVING, who represented Walworth, Ltd., in the Midlands and the West Country, has retired after a long period of service with the company, having begun with its predecessor, H. Munzing, as a warehousman in 1890. He became an outside representative in 1908. From 1921 to 1927 he was manager of the Glasgow branch and since 1927 had made Birmingham his headquarters.

Officers of the North-Western branch of the Institution of Chemical Engineers for the coming year were elected at the annual meeting in Manchester on January 3 as follows: chairman, MR. T. PENNY; vice-chairman, MR. J. MCKILLOP; hon. secretary, MR. A. REES JONES; committee, MR. E. C. B. BOTT, MR. G. BREARLEY, MR. F. BROADBENT, MR. C. COOPER, MR. C. J. T. CROXSHAW, MR. J. F. C. GARTSHORE, MR. J. S. HUNTER, MR. I. P. LEWELLYN, MR. J. M. WISHART, and MR. E. WOOLLATT.

Obituary

DR. L. V. REDMAN, of Nelson, Ontario, who recently died of a heart attack while visiting Toronto, was well known for his achievements in the invention and development of plastics.

Formerly assistant professor at the University of Kansas, where he was active in researches on synthetic resins, he later became president of the Redman Products Co., of Chicago, in 1914, and with the merger of the company with the Bakelite Corporation, was appointed vice-president and director of research. In 1931, Dr. Redman was elected president of the American Chemical Society. He was chairman of the Chicago section, and later of the North Jersey section of the A.C.S. He was a past chairman of the American section, Society of Chemical Industry, and past president of the Chemists' Club of New York. Dr. Redman was a fellow of the American Association for the Advancement of Science, a member of the American Institute of Chemical Engineers, of the American Institute of Chemists, and of the Chemists' Clubs of Chicago and New York.

Many honours were conferred upon Dr. Redman. He was awarded the Graselli Medal for the best article written and published on chemistry at the time of the award. He also won the gold medal awarded by the Society of Chemical Industry for the most outstanding contribution to chemical science during that period. The University of Toronto conferred upon Dr. Redman the honorary degree of Ph.D. and McMaster University the honorary degree of D.Sc. He was a fellow of the Canadian Institute of Chemistry.

COMING OF AGE OF E.T.S.

CELEBRATIONS IN LONDON

IT was a memorable occasion for members of the Electrodepositors' Technical Society when, at their headquarters, the Northampton Polytechnic, London, on December 7, they gathered to celebrate the 21st anniversary of the Society's foundation.

A large company of members and visitors was present. Dr. S. Wernick, the president, was in the chair, and welcome personalities supporting him were the Society's first president, Mr. Samuel Field, and most of the succeeding presidents, including Dr. R. S. Hutton, Mr. R. E. A. Ollard, Dr. H. J. T. Ellingham, Mr. A. W. Hothersall and Dr. J. R. I. Hepburn. Also on the platform were the vice-president, Dr. G. E. Gardam; the honorary treasurer, Mr. F. L. James; and Major L. H. Peter, chief engineer for Westinghouse Brake and Signal Co.

The 21 years of the Society's history was appropriately illustrated by graphs and diagrams, displayed behind the platform and demonstrating its achievements and the expansion of its membership and activities; while the latest types of electro-deposits and also electrolytic polishing, as well as intricate instruments developed in recent years for the control of electro-deposits, were also on exhibition.

Founders

Recalling the first meeting in that same building twenty-one years before, the president said there were four outstanding individuals who might be looked upon as founders: Mr. Spiers, at that time secretary of the Faraday Society; Mr. Samuel Field, head of the Chemistry Department of Northampton Polytechnic; Mr. W. E. Harris, who became the first honorary treasurer; and the late Mr. William James, first honorary treasurer and father of the present honorary treasurer.

Dr. Wernick quoted messages of congratulation from sister societies, among them those from Professor Hinshelwood, president of the Chemical Society; Dr. Roche Lynch, president of the Royal Institute of Chemistry; Dr. Z. De Ferranti, president of the Institution of Electrical Engineers; Mr. G. W. S. Marlow, secretary of the Faraday Society; Mr. F. K. Savage, president of the American Electroplaters Society; Dr. Colin Fink, secretary of the American Electrochemical Society; and several Continental societies. Especially appreciated was a letter from the Society's first secretary, Mr. Harris, now living in Canada.

An interesting announcement by the president was that of the council's decision

to institute a medal, to be known as the E.T.S. Medal, and to be awarded at intervals to individuals considered to have performed outstanding services in the field of electrodeposition. It was hoped the medal would be international in scope.

The unanimous decision of the council, said Dr. Wernick, was that there was no more meritorious claim to the first award of the medal than that of the Society's first president, Mr. Samuel Field. Prolonged applause followed, as the president handed Mr. Field a scroll in token of the medal, which has yet to be cast.

Acknowledging the award, Mr. Field said he had certainly taken some part in the Society's foundation but had little thought the time would come when it would hold such an honoured place in connection with the research and industrial developments that had taken place in the field of electrodeposition.

Professor Hutton, Mr. Hothersall, Mr. Ollard, Dr. Ellingham, Mr. B. J. R. Evans, one of the founders of the Society's flourishing Midlands Centre, and Major Peter also addressed the Society. The latter handed the president a cheque for 250 guineas from the Westinghouse Brake and Signal Co. towards the Society's Publications and Development Fund.

Non-Ferrous Scrap Metals

Latest Prices

THE Ministry of Supply has issued a list of selling prices of non-ferrous scrap metals at Ministry of Supply depots, where sales will be held when sufficient material of the quality required is available. The list refers to delivery until the end of April and is published without prejudice or commitment. Inquiries regarding the list should be addressed to Directorate of N.F. Metals (Scrap Disposals Department), 41-43 Norfolk Gardens, London, W.C.2.

The following is a summary of the prices per ton of the various classes of scrap listed: Copper—scrap, £107 to £110 10s.; turnings, £98. Zinc—scrap, £58 10s. Brass—scrap, £80 to £93 10s.; turnings, £79; 70/30 metallics, £73 10s.; 60/40 rod swarf, £73 10s.; 60/40 broken down fuse scrap, £82; 90/10 gilding metal scrap, £100 10s. to £103; 95/5 cap metal webbing, £104. Scrap bullet envelopes—copper-nickel, £104 10s.; gilding metal, £89.

NEXT WEEK'S EVENTS

MONDAY, JANUARY 13

Institution of the Rubber Industry. James Watt Memorial Institute, Great Charles Street, Birmingham, 7.15 p.m. Mr. W. H. Chapman: "Foamed Rubber Latex and Allied Products."

TUESDAY, JANUARY 14

Society of Chemical Industry. The University, Liverpool, 6.30 p.m. Mr. P. N. Williams: "Synthetic Fats."

Chemical Society (Plastics Group). Burlington House, Piccadilly, London, W.1, 6.30 p.m. Dr. H. P. Standinger: "Vinylidene Chloride and its Polymers."

Society of Instrument Technology. Manchester College of Technology, 7.15 p.m. J. D. Tallantire: "Continuous Process Measurement in Dirty Fluids."

WEDNESDAY, JANUARY 15

Royal Statistical Society (Industrial Application Section, Birmingham and District Group). Chamber of Commerce, 95 New Street, Birmingham, 6.30 p.m. Mr. V. E. Gough: "Statistical Definitions and their Consequences."

Institute of Welding. The Fyvie Hall, Polytechnic, Regent Street, London, W.1, 7.30 p.m. Mr. R. G. Braithwaite: "The Application of Welding to Steel Structures."

Institution of Chemical Engineers

Forthcoming Annual Meeting

THE 25th annual corporate meeting of the Institution of Chemical Engineers will be held at the Connaught Rooms, Great Queen Street, London, W.C.2, on April 10 at 11 a.m.—not on April 11 as previously announced.

The following are the nominations of the Council to fill forthcoming vacancies: President, Mr. H. W. Cremer; vice-presidents, Mr. S. Irwin Crookes, Mr. V. F. Gloag, Mr. J. Davidson Pratt, Mr. S. J. Tungay; joint hon. secretaries, Mr. M. B. Donald, Mr. L. O. Newton; hon. treasurer, Mr. F. A. Greene.

Nominations from members must be received at the registered office of the Institution, 56 Victoria Street, London, S.W.1, not later than February 28. In the event of there being no nominations from members, no ballot will be necessary, and the nominees

Royal Institute of Chemistry. London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, 6.30 p.m. Mr. A. C. Monkhouse: "Recent Advances in Atmospheric Pollution Research."

Textile Institute. Textile Institute, Manchester, 7.30 p.m. Mr. J. A. McWilliam: "Corrosion Resisting Steel for the Textile Industry."

THURSDAY, JANUARY 16

Society of Chemical Industry. (Road and Building Materials Group). Gas Industry House, 1 Grosvenor Place, London, S.W.1, 6 p.m. "Recent Developments in Testing Methods for Road and Building Materials."

FRIDAY, JANUARY 17

Chemical Society. The University Chemical Laboratory, Cambridge, 8.30 p.m. Professor M. Stacey: "Macromolecules Synthesised by Micro-organisms," (Tildea Lecture).

Society of Chemical Industry (Chemical Engineering Group). Geological Society's Rooms, Burlington House, Piccadilly, London, W.1, 5.30 p.m. Mr. F. A. Rivett: "Flame Spraying of Metals and Plastics by the Powder Process."

Institute of the Plastics Industry and Institution of the Rubber Industry. Engineers' Club, Manchester, 6.45 p.m. Dr. T. Love and Mr. J. H. Rooney: "Thermosetting" and "Thermoplastics."

of Council will be declared elected at the annual corporate meeting.

The time-table of the meeting is as follows: 11 a.m., Business meeting for corporate members only; 12 noon approximately, president's address; 12.45 for 1 p.m., luncheon, at which it is expected that a number of important guests will be present. No arrangements have so far been made for an afternoon session.

Lever Brothers (East Africa), Limited, has been incorporated in Kampala for the purpose of developing a local industry based on oil seeds according to *The Times*. Plans have been made for the erection of an oil mill and soap factory at Kampala costing £750,000. The total yearly capacity will be about 40,000 tons, and the factory will be designed for the processing mainly of locally grown cotton seed. The construction of the factory will begin almost immediately.

Home News Items

The price of antimony, English 99 per cent, has been advanced £25 to £150 per ton delivered, and crude 70 per cent by £20 to £125 per ton.

D.T.D. Specification No.424, "Aluminium Alloy Castings for General Purposes," has been reprinted to incorporate Amendment Lists Nos. 1, 2 and 3, and is obtainable from H.M. Stationery Office (1s.).

The **Aluminium Development Association** has moved from 67 Brook Street, London, W.1., to more suitable premises at 33 Grosvenor Street, London, W.1. The telephone number remains unchanged—Mayfair 7501.

A list of members and classified index of their products has been issued by the British Chemical Plant Manufacturers' Association, 26 Portland Place, London, W.1, as an interim publication pending the issue of *British Chemical Plant 1947/48*, an illustrated publication now in course of preparation. Copies of this list are obtainable from the Association on request.

In Scotland, the oils, colours and chemical industries received an increased degree of financial support last year, compared with 1945. New companies registered in Edinburgh in 1946 involved a capitalisation of £429,500, as against £100,700 invested in new companies in this field in 1945. This increase is indicative of the general trend in flotation, last year's new company registrations in Scotland being the highest for seventeen years.

Economic reconstruction, in various aspects, will be dealt with in a series of eight lectures to be given under the auspices of the Royal Society of Arts in the library of the Society's house in John Adam Street, Adelphi, London, W.C.2. The first lecture, "Great Britain in Relation to the World's Trade Situation," will be given by Sir Charles Liddbury, chief general manager of the Westminster Bank, Ltd., on January 15 at 5 p.m.

Business men are now permitted to visit the British and American Zones in Germany for commercial purposes, but owing to the limited facilities in accommodation and transport, applications can only be considered from persons having a specific purchasing transaction in view. Applications to Sundry Materials Branch of the Board of Trade, 10, Old Jewry, London, E.C.2., should be accompanied by firm enquiries for specific goods and the names of the German suppliers with whom they wish to deal, should be stated.

A saving of between 250 and 300 tons of coal a week, it is estimated, will be effected by the conversion to fuel oil of two large coal burning steel smelting furnaces of the English Steel Corporation, Ltd., Sheffield.

Copper sulphate (98/100 per cent) has been increased by £4 7s. 6d. to £41 17s. 6d. per ton (less 2 per cent) in 2 cwt. bags (free) f.o.b. Tungsten ore prices now range from 70s. to 73s. per unit, c.i.f.

The **A.B.C.M.** has secured permanent offices for its branch office in Bombay. The address is: Association of British Chemical Manufacturers, Janmabhoomi Chambers, Fort Street, Ballard Estate, Bombay, 1, India. (Tel.: Bombay 30457; telegraphic address, Manuchem, Bombay).

The **issue price of tungsten ore** of standard grade has been increased by the Ministry of Supply from 70s. to 75s. per unit of WO₃, delivered consumers' works. For special high-grade scheelite to the following specification: WO₃ minimum 68 per cent, tin maximum 0.60 per cent, arsenic maximum 0.10 per cent, molybdenum maximum 0.10 per cent, the price is 80s. per unit WO₃, delivered consumers' works.

The **Institution of Chemical Engineers** has been informed by the Ministry of Education that steps are being taken to initiate courses in chemical engineering at Walthamstow, Loughborough, Bradford and, possibly, Widnes. For the successful development of these courses, teachers are required, and the Institution has been asked to help in this connection. If any member would care to consider taking up such a position, he should communicate with the Joint Hon. Secretaries, when his application will be placed before the authorities.

The **first of the new cupro-nickel coins**, dated 1947, were issued by the Bank of England on Thursday last week. In appearance, size, design and weight the new coins are almost exactly the same as the silver coins which they are replacing, the only noticeable difference being a slightly glossier surface. Denominations of the coins now being issued are half-crowns, florins, shillings and sixpences. According to the *Financial Times*, the replacement of the existing silver coinage by cupro-nickel coinage will not be completed for several years. It is estimated that the silver derived by melting down the existing coinage will provide sufficient metal to cover the essential needs of British industry for some years to come and to repay to the U.S. Britain's Lease-Lend debt of 327,000,000 ozs. of silver.

Britain's steel output should be between 13,000,000 and 13,500,000 ingot tons this year, according to an estimate by the British Iron and Steel Federation. This compares with 12,690,000 tons in 1946, when coal shortage reduced production by 500,000 tons. The steel industry is now constructing new capacity which will enlarge production by 2,000,000 tons.

The Valor Co. Ltd. is opening a branch factory at Chapelhall, Nr. Airdrie, Scotland which will cover about 25,000 square feet and will ultimately find work for between 200 and 250 additional employees. It was originally intended that production would start before the end of 1946, but owing to unavoidable delays in obtaining necessary building materials the factory is not yet completed.

The Physical Society has planned to hold the 31st Exhibition of Scientific Instruments and Industrial Apparatus from April 9-12 inclusive, in the Physics and Chemistry Departments of Imperial College, South Kensington, London, S.W.7. The exhibition is usually held in January.

The inland parcel rates of postage have been increased by 1d. at each step of the scale. The new rates are therefore: Not over 3 lb., 8d.; not over 4 lb., 9d.; not over 5 lb., 10d.; not over 6 lb., 11d.; not over 7 lb., 1s. 0d.; not over 8 lb., 1s. 1d.; not over 15 lb. (max.), 1s. 2d. This increase in the parcel post rates brings them again into harmony with the railway companies' general parcel traffic scales which were increased last July.

Overseas News Items

Czechoslovakia is now exporting small quantities of antimony ore to Holland.

At the Utrecht Spring Fair, to be held between March 11 and March 30, the chemical and pharmaceutical groups are to be expanded considerably.

Tinplate production restrictions have recently been removed in the United States and it is expected that the system under which lead is allocated for the production of chemicals will soon be terminated.

A new factory is to be built at Bulawayo by the General Chemical Corporation, Ltd., according to a statement made at the recent annual meeting. The Chairman, Mr. S. Hayden, said six acres of land had been acquired for the purpose.

The first firm in China to manufacture penicillin on a large scale will be opening in Peiping shortly, states a Nanking report. Equipment for the plant was presented to China by the American Bureau of Medical Aid to China.

It is reported from Italy that the production of chemical products and the demand for them is increasing daily, although the raw material situation is unsatisfactory. The domestic coal production has fallen to 100,000 tons per year on account of the hand-over of the Aras Mines to Trieste.

Because of increased demands for tapered nylon brush bristle, Canadian Industries, Ltd., will spend more than \$150,000 on expansion and improvement of its plastic plant in Brownsburg, Que., according to a recent announcement. The Brownsburg plant is the only one of its kind in Canada turning out nylon monofilament.

Lignite deposits in Southern Bohemia are to be exploited.

Under a Franco-Italian trade agreement signed recently in Rome, France is to export potassium, bauxite, scrap metal and steel, while she will receive sulphur, oils and other goods.

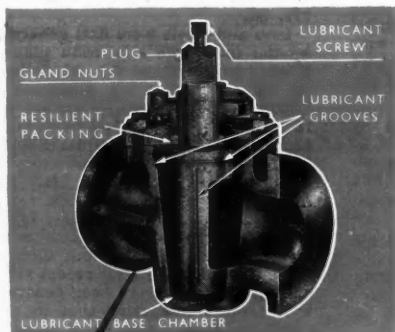
Norway is to export to Holland pulp for use in the artificial silk industry, pyrites as well as alloys. In return, she will receive among others, superphosphates and chemical products.

Penicillin is to be cheaper in Australia, the Minister for Health having approved substantial reduction in prices charged by the Commonwealth Serum Laboratories. In some cases, the reduction will exceed 50 per cent.

Dyestuffs are reported to be getting scarce in Shanghai because large stocks, which have been taken over from German companies, have been practically used up. At the present rate of consumption, supplies may last for another six months.

A \$1,000,000 salt industry is to be established by the Dominion Tar & Chemical Co. 90 miles northwest of Saskatoon, Saskatchewan. An agreement covering the development has been signed between the Saskatchewan Government and the company, which has its head office in Montreal.

Sulphur exports from Italy are reviving. Poland has agreed to import 8000 metric tons, Belgium 3860 tons, France 10,000 tons, and Hungary 2000 tons, under trade agreements signed with these countries. Furthermore, private transactions have been concluded with Yugoslavia, Austria and Turkey for exports totalling about 15,000 tons.



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Company News

Power Gas Corporation, Ltd., reports trading profit of £117,852 for the year ended September 30 last, as compared with £74,533 for the previous year. The dividend is 12½ per cent; previously, it was 10 per cent, plus 2½ per cent bonus.

Trading profit of £80,547 is reported by **British Emulsifiers, Ltd.**, for 1945. The previous year it was £43,936. After an E.P.T. charge, income tax charges and capital expenditure, no dividend is recommended.

Increased net profit, amounting to £224,463 as compared with £132,320 for the previous year, is reported by **English Clays Lovering Pochin & Co., Ltd.**, for the year ended September 30 last. The ordinary dividend of 5 per cent compares with 3½ per cent.

New Company

Mastermax Ltd. (426,556).—Private company. Capital £1,000 in £1 shares. Manufacturers of and dealers in plastics; natural and synthetic resins; dyes; pigments; rubber products, etc. Directors: J. Silman; E. Baron. Registered office: 108A, Cannon Street, London, E.C.4.

Chemical and Allied Stocks and Shares

BRITISH Funds strengthened afresh, but other sections of stock markets were easier earlier in the week, industrial shares being affected by the fuel position, although in most cases declines did not exceed more than a few pence. Home rails became less firm, and Cable & Wireless reflected a little profit-taking, but among other nationalisation groups, electric supply shares again reflected hopeful assumptions as to the compensation basis.

Chemical and kindred shares continued somewhat more active, but Imperial Chemical eased to 45s. 9d. after touching 46s. 3d. Higher dividend hopes kept Borax Consolidated deferred firm at 49s. 3d., Lever & Unilever at 55s. moved higher on balance, while Turner & Newall at 90s. 6d. responded to the annual results and the company's expansion programme. B. Laporte were again 103s., Fisons have changed hands up to 67s., Lawes Chemical firmed up to 17s. 3d., British Drug Houses (66s.) remained active on the benefits likely to derive from the abolition of E.P.T., and Greeff Chemicals Holdings 5s. shares were 13s. 6d. Activity up to 59s. 3d. was displayed by Morgan Crucible "A" ordinary. Cooper McDougall were

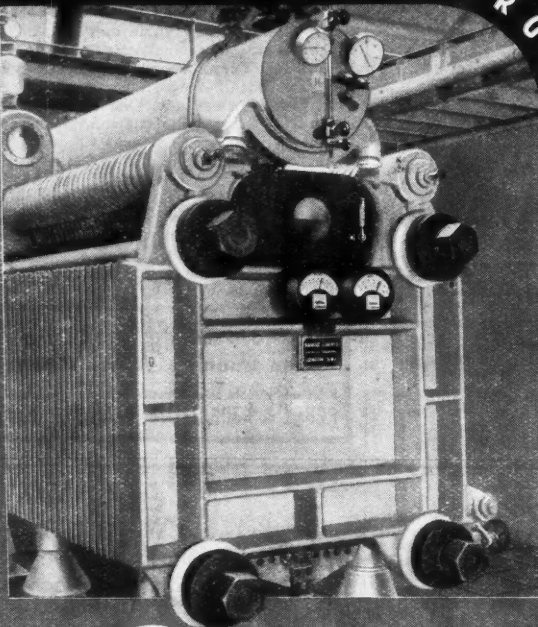
dealt in around 43s. 3d. Current market dividend estimates drew attention to British Alkaloids 1s. shares, which moved higher at 17s. 3d.

Iron and steels were firm generally, helped by the industry's expansion plans. United Steel were steady at 28s. 3d. following news of the company's big preference issue to finance developments. Dorman Long preferred have been good at 52s., Colvilles firmed up to 26s. 3d., John Summers were 36s., and yield considerations also drew attention to T. W. Ward (51s.). Stewarts & Lloyds moved higher at 58s. 1½d., Thomas & Baldwins were firm at 11s. 7½d. on news of the big orders for tinplate, while Allied Ironfounders were 65s., but Guest Keen at 47s. 6d. lost part of their recent rise. Colliery and allied shares have been generally helped by estimates indicating that in many cases current market prices are below break-up values of the shares. Staveley firmed up to 54s. 9d., Sheepbridge were 47s. 6d., with Powell Duffryn steady at 26s., and Shipley 44s. 6d.

A sharp rise to 57s. in German Potash bonds reflected the hope that fusion of the British and U.S. zones will accelerate resumption of interest payments. Low Temperature Carbonisation 1s. shares have moved up to 4s. 6d., and a good feature was a strong rise to 24s. 6d. in General Refractories on the view that expansion of the iron, steel and other industries counotes growing demand for the company's products. Plastics were featured by Kleemann shares, which advanced to 75s. 6d., while De La Rue were higher at 14½, British Industrial Plastic 2s. shares were 8s. 3d., and in other directions, the units of the Distillers Co. changed hands around 139s. British Plaster Board 5s. ordinary at 34s. 6d. have not held best levels, while Associated Cement eased to 67s. 9d., attributed to the fuel position. Dunlop Rubber eased to 75s., and United Molasses to 57s. 6d., but elsewhere, Barry & Staines were firm at 59s. 9d. Nairn & Greenwich moved up 1s. 3d. to 86s. 3d. awaiting the dividend, and Wall Paper Manufacturers deferred 49s. 6d. were higher. Shares of another South African concern, General Chemical Corporation, are likely to be introduced shortly to the London Stock Exchange.

Boots Drug strengthened to 64s. 6d., Beechams deferred were 28s. 4½d., and Sangers higher at 35s. 6d., the latter on probable benefits the company will derive from the abolition of E.P.T. United Glass Bottle have changed hands round 95s., and glass shares generally were rather more active, partly on E.P.T. considerations. Triplex Glass have been steady at 38s. Oils generally reflected profit-taking, although Anglo-Iranian rose afresh to 6½ awaiting further news of the proposed U.S. agreement regarding Middle East oil interests.

FROM THE LARGEST TO THE SMALLEST

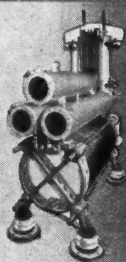


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British Chemical Prices

Market Reports

THE demand for industrial chemicals in the London market during the past week has been strong and interest if anything over a wider field with a result that supply problems too are more widespread. * Contract deliveries are now back to normal and renewal bookings are being negotiated, in some instances at revised rates. The increase in the controlled prices for copper, lead and zinc has affected the quotations for chemicals and pigments. A new price schedule for lead oxides, dry, ground in oil, and ready mixed paints came into force on January 1. Genuine dry red lead is now quoted at £86 per ton, and the ground in oil £107 per ton. Dry white lead bulk quantities is now £97 10s. per ton. Zinc oxide has been increased by £12 15s. per ton. Conditions in the coal-tar products market remain steady with the demand both for home and export undiminished.

MANCHESTER.—The Manchester chemical market has re-opened after the holidays on a very firm note so far as prices are concerned, with higher rates indicated for a fairly wide range of products, including the red and white leads, blanc fixe, precipitated carbonate of barium, all grades of sulphide of soda, oxide of zinc, acetic acid, and the ethyl acetate and other solvents. The undertone of pretty well all other materials

is extremely strong and other advances are anticipated. There has been plenty of fresh inquiry, both from home users and for shipment, and deliveries against existing orders are being steadily called for. Anxiety regarding the supply position of the alkali products has been increased by the announcement that owing to the coal shortage production is to be further substantially reduced.

GLASGOW.—As a result of New Year holidays, which, in some cases, occupied three or four days, very little can be said about business in the Scottish heavy chemical market. There seems to be a general opinion that 1947 will be a year of increasingly high prices and shortage of essential supplies. The coal situation is tending to restrict production, if not to cause actual stoppages. Transport and shipping delays are also contributing to present a picture which is far from bright. Price increases so far notified include ammonium carbonate, sulphated fatty alcohols, sulphuric acid and Glauber salts, and with the recent increase in the cost of lead, zinc and copper, it is

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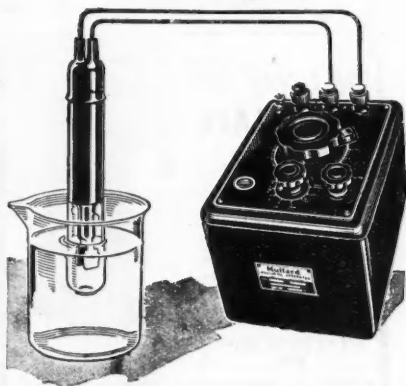
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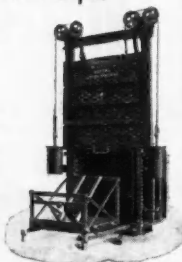
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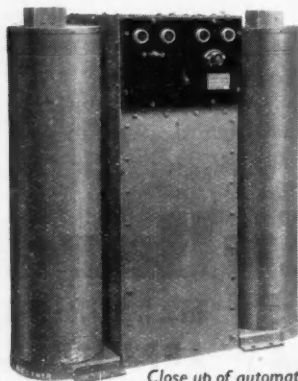
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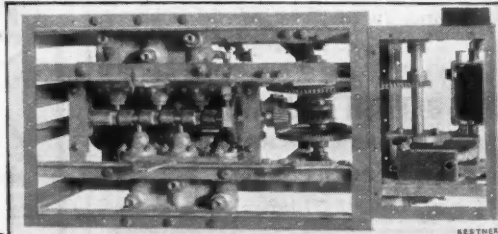
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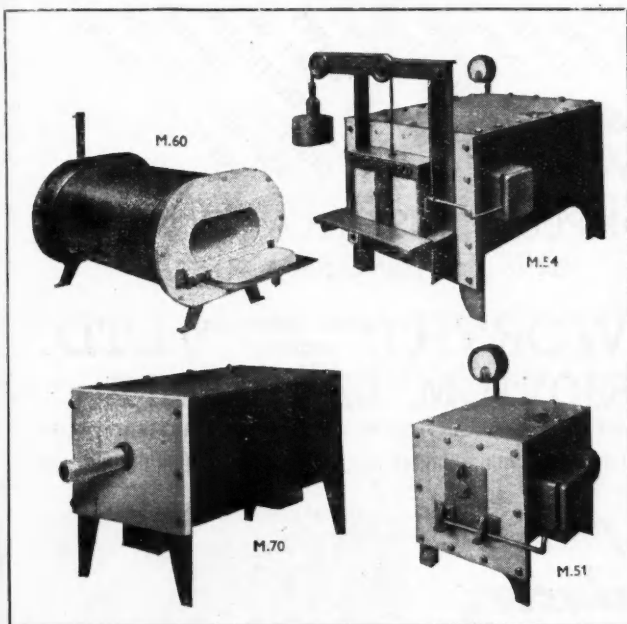
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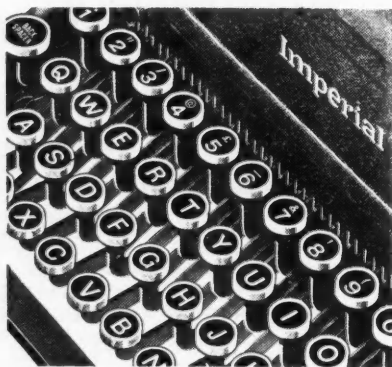
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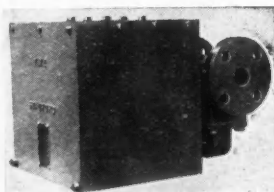
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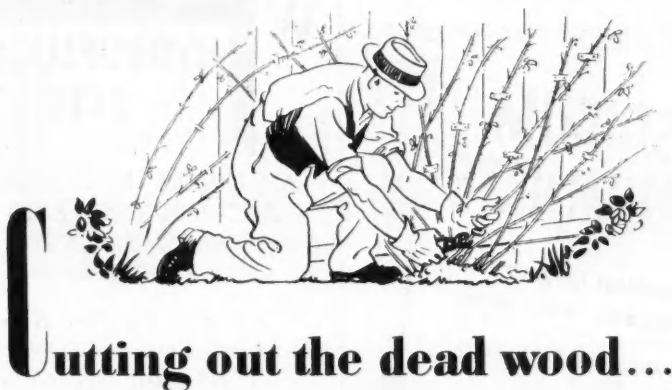


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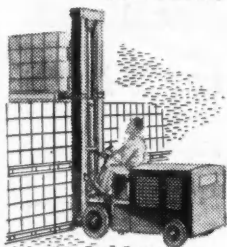
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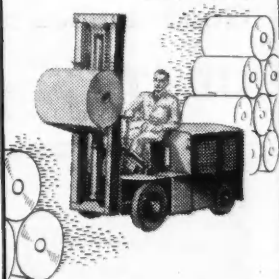
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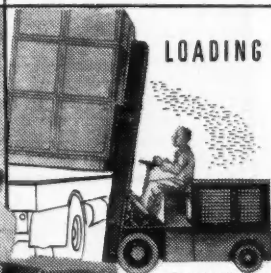
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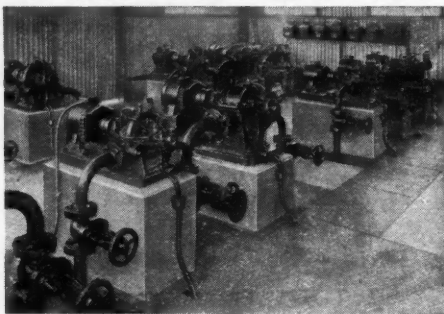
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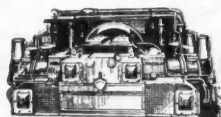
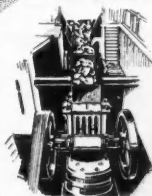
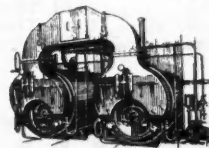
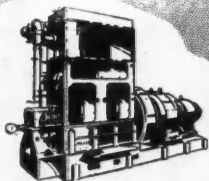
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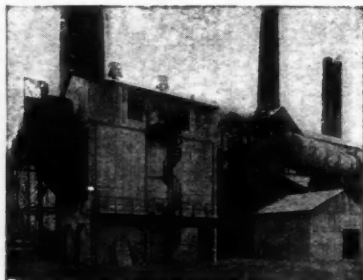
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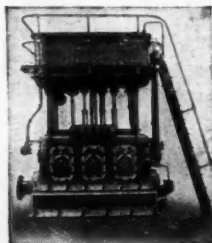
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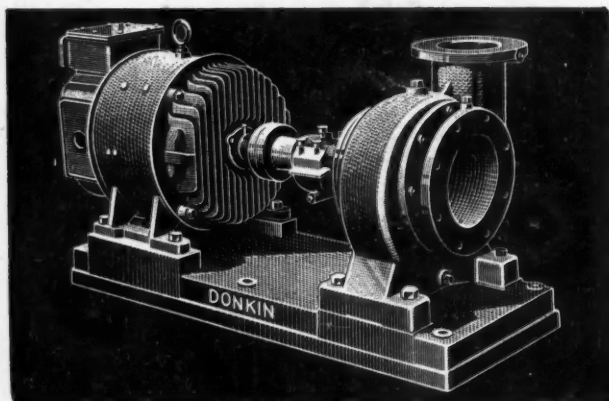
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